AN ABSTRACT OF THE THESIS OF

Kenneth R. Greene for the degree of Doctor of Philosophy in Nuclear Engineering presented on May 13, 1991.

Title: Nonintrusive Intelligent Monitoring for Nuclear Power Plant Emergency Classification

Abstract approved: Redacted for Privacy

Alan H. Robinson

A prototype real-time process monitoring emergency classification expert system, RT/EM-CLASS, has been developed for use at the Trojan Nuclear Power Plant. This knowledge-based system features the integration of electronically sensed plant data with the menu selection data representation of its predecessor, EM-CLASS. This prototype demonstrates the techniques required to acquire plant process data from another computer and use that data in an expert system to determine the proper Emergency Action Level.

Several benefits are realized by the RT/EM-CLASS application. These include:

- The resources required to make a classification are reduced thereby freeing the responsible person to devote time to other important tasks.

- The classification may be completed more often and with better data than the current system allows.

- The human user is less likely to make an erroneous Emergency Action Level classification.

Prototype implementation required resolution of an efficiency problem of relating plant process data to the expert system data forms. This was achieved through the development of multi-conditional rules that significantly reduce the size of the rule set.

The development of RT/EM-CLASS presents a methodology for building knowledge based applications that perform non-intrusive real-time monitoring of dynamic systems. This methodology features

- Use of existing analytical and AI tools where possible
- Monitoring of a dynamic system
- Non-intrusive acquisition of data from the system

This technology might be applied to portions of the nuclear engineering design process (control rod programming in Boiling Water Reactors, for example) to emulate the guidance and activities of an expert. A substantial portion of the effort by the expert engineer involves preparation of the code input, running the computer code, analyzing the results, and based on the results, deciding what case to submit next. A suitably designed expert

system could act in the place of the engineer in this dynamic design process.

This methodology has been tested against the 1988 emergency exercise at the Trojan Nuclear Power Plant.

Nonintrusive Intelligent Monitoring for Nuclear Power Plant Emergency Classification

by

Kenneth R. Greene

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed May 13, 1991

Commencement June 1992

APPROVED:

Redacted for Privacy

Professor of Nuclear Engineering in Charge of Major

Redacted for Privacy

Head of Department of Nuclear Engineering

Redacted for Privacy

Dean of Graduate School

Date thesis is presented May 13, 1991

Typed by Kenneth R. Greene for Kenneth R. Greene.

Acknowledgements

Throughout this endeavor, several people provided help and support, without which, this work would not have been possible. First, thanks go to Alan Robinson, my major professor, who provided guidance, equipment, and arranged for financial support of this project. I would like to thank Portland General Electric Co. who sponsored this research. Finally, I would like to thank the other members of my committee, Jose Reyes, Jack Higginbotham, Ken Funk, and Roman Schmidt.

This work would not have been possible without the undivided support of my wife, Beth, and sons, Ian and Bryan. Their sacrifice was essential to make this work possible. Finally, thanks go to Johanne Baker who provided substantial personal support for my family while this work was in progress.

Table of Contents

List of Figures

Nonintrusive Intelligent Monitoring for Nuclear Power Plant Emergency Classification

1. Introduction

Emergency response in nuclear power plants is contingent on making the correct classification. Application of knowledge based system technology to emergency classification improves both the quality of the classification and human reliability.

An Emergency Classification expert system, EM-CLASS (EMergency CLASSification; Heaberlin, 1989), was developed to automate the process of classifying emergencies at the Trojan Nuclear Power Plant. This system provided increased reliability in the classification of emergencies. The task of inferring the correct classification from multiple parallel paths of several modules is taken care of internally by the inference engine of the expert system. However, testing revealed that emergency classification by flip chart method (the one currently in use at PGE) was faster than classification with the expert system.

During a plant emergency, an environment will exist where there are not enough resources to complete all the desired tasks. To alleviate this resource shortage, some tasks must be accomplished with greater efficiency. The EM-CLASS application

may be improved by taking advantage of the fact that up to 90% of the responses to the questions in the Trojan Emergency Procedures (Portland General Electric Co.), are available directly from plant measurements. This information could be passed to the expert system electronically.

Three advantages are immediately apparent from such an implementation. First, human users are less likely to make an error leading to an incorrect Emergency Action Level classification. Second, the classification may be completed more often and with better data than the current system allows. Third, by shifting some of the resources required to perform the classification away from the human user, he is available to address other important emergency management tasks with greater attention than current operating practice allows.

2. Background

Emergency planning is an essential requirement at nuclear power plants. This is mandated by law in the United States. (10 CFR 50, Appendix E; NUREG-0654). Considerable attention on emergency planning resulted following the incident at Three Mile Island Unit 2 in 1979. The activities contributing to the accident are improper maintenance practices [valve improperly left closed on Auxiliary feedwater system], incorrect decisions by operators [turning off the emergency core cooling system], design flaws in the plant, and lack of accurate timely information on plant status (Bernard, 1989; Livingston, 1980).

A nuclear power plant is a very complex dynamic system. Yet for much of its life it is operated steady state, at maximum power. It is shutdown once every one or two years for refueling and maintenance. The problem, as you might anticipate, is what happens when the plant unexpectedly assumes an abnormal state that is dynamically changing from moment to moment? For certain postulated but rare events there is little operational experience (for example, there has never been a main steam line break in a commercial nuclear power plant) and hence no practice. Due to the long periods of steady state operation, the human operators do not exercise their skills for controlling the dynamic nuclear system. Although they are expected to react favorably at

any time during the plant operation, they may react unfavorably because human beings make poor monitors of dynamic systems (Edwards, 1976). "Monitor" means that the human is not in active control of the system but is expected to maintain plant state awareness at a level consistent with being in active control. The operator must be able to assume active control at any instant.

How do you prevent seemingly innocuous but abnormal events from becoming major catastrophes like Three Mile Island or Chernobyl? This question produced a flurry of activity in the nuclear industry in the years following TMI 2. Several approaches have been pursued. These include retrofit design changes ("ratcheting" in nuclear industry parlance), increased training (Trojan operators now spend one week out of every five in training), and human factors engineering (Safety Parameter Display System, SPDS, to convey clearly the state of the plant). It is not surprising that Artificial Intelligence (AI) technologies are also receiving consideration to assist plant operators during emergencies. Of the Artificial Intelligence technologies, expert systems have received the most attention.

2.1. Expert Systems

What is an expert system? One definition states that an expert system is an application resident on a computer that emulates the behavior of an expert in solving a problem in a

narrow domain (Rich, 1983). In the artificial intelligence topology, an expert system is a subset of a knowledge based system. A knowledge based system is a computer based application that uses knowledge and inference to solve non-trivial problems that might otherwise require an expert to solve. The primary distinguishing difference between an expert system and a knowledge based system is that an expert system is constructed with knowledge obtained directly from human experts whereas a knowledge based system uses knowledge that may be obtained from other sources.

A knowledge based system is composed of two primary parts - the knowledge base and the inference engine. The knowledge base is the collection of knowledge which determines how the problem may be solved. The knowledge is composed of two parts: procedural knowledge, as rules, and factual knowledge, as objects that have attributes. These objects are manipulated by the rules. The inference engine is generic, that is, it is problem independent. Inference is the process of applying procedural knowledge to existing facts to infer new knowledge.

An example will help clarify the roles of the parts of an expert system knowledge base. Consider the following rule:

IF color of toast is black **THEN** toast is burned

Premise Conclusion

The rule is composed of two parts: a premise and a conclusion. The object is "toast." This object exhibits several attributes. It has a name (toast), a color (white, brown, or black), and a state (burned, toasted, untoasted). The "toast could be assigned a "spread" attribute (none, butter, jam). This example illustrates the robust nature of knowledge representation in expert systems.

Inference engines for expert systems are based on one of two primary strategies: forward chaining and backward chaining. The characteristics of problem being solved will dictate the appropriate strategy to use. Forward chaining inference is most appropriate for configuration type problems where many possible end states (results) could be produced. For this strategy, the inference engine uses the premise of the rule as a condition for "firing" the rule. Firing a rule implies action. Simply stated, firing a rule means that the rule is *applied* because it may lead to problem solution. Backward chaining is most appropriate for diagnostic tasks where a few end states are possible. For backward chaining strategies, the inference engine uses the conclusion of a rule as the basis for determining if the rule is to be fired.

Expert systems are often developed with a shell. A shell is essentially a completed expert system application with the problem specific coding (knowledge base) removed. Figure 1 illustrates the parts of an expert system shell. Ideally, to solve a new problem, one only needs to supply an applicable knowledge base. This points out an important distinction between conventional problem solving and problem solving with artificial intelligence technologies. The parts that make up the expert system are separated. This allows easy reuse of the generic parts of the coding without modification. In conventional problem solving, the functional equivalents of the inference engine,

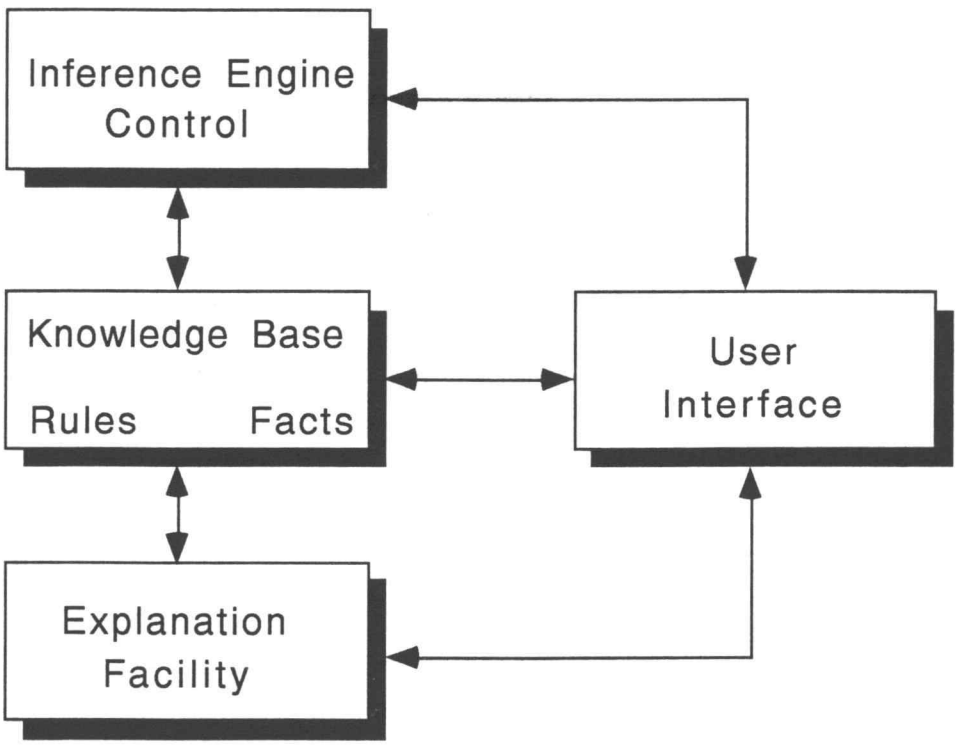


Figure 1. Expert System Shell Architecture

knowledge base, explanation facility (if it exists), and the user interface are all mixed together in the computer program. Conventional programs are therefore more difficult to maintain.

A pertinent consideration in the implementation of expert systems is the role which they are expected to fulfill. Do expert systems replace human beings? In the nuclear industry, the answer is no. Expert systems are intended to assist the human. It is a tool that allows an already knowledgeable human to increase productivity (Bernard, 1989).

2.2. Emergency Classification

Emergency classification is the subject of several expert systems. These include RSAS (Sebo et.al., 1985; Sebo et.al., 1986; Sebo et.al., 1988), EP (Salame-Alfie et.al., 1988), REALM (Touchton et.al., 1985; Touchton et.al., 1987; Touchton, 1988), and EM-CLASS (Heaberlin, 1989; Heaberlin et.al., 1990).

RSAS was developed at the Idaho National Energy Laboratory. It is an application directed toward the United States Nuclear Regulatory Commission. The intent is to provide aid to a reactor safety team during an accident or abnormal event at a domestic commercial nuclear power plant. Some of the data for this application is currently acquired through voice transmission from

the afflicted plant. It is a forward chaining system, written in LISP. The most interesting feature of the system is the idea that parameter values acquired from a dynamic system have a lifetime. They are therefore tagged with an expiration time after which they are discarded.

EP is an application designed to assist in the coordination and management of a commercial nuclear power plant accident. It is specifically targeted toward satisfying regulations in the State of New York.

The Reactor Emergency Action Level Monitoring System (REALM) was developed by Technology Applications, Inc. This expert system helps Consolidated Edison (operators of Indian Point 2) classify emergencies. REALM was developed with KEE (Knowledge Engineering Environment, by Intellicorp) and contains approximately 300 rules and 700 objects. Originally it ran on a specialized LISP machine. Between 10 and 30 percent of the input data must come through the keyboard. The remainder is obtained electronically from the plant process computer.

An emergency classification expert system, EM-CLASS, was developed to classify emergencies at the Trojan Nuclear Power Plant. EM-CLASS was developed with the expert system shell Personal Consultant™ Plus (Texas Instruments, Inc., 1988) and operates on an IBM PC-AT compatible personal computer. It

contains over 230 rules and 100 parameters. This system provided increased reliability in arriving at the proper classification. EM-CLASS did all the tracing of the flow charts and reduced the cognitive workload of the user to that of providing the data required to deduce a classification, i.e., answering questions. The questions provide a menu of selections for the user to choose from. By doing so, the chance of keyboard entry error while entering numbers is significantly reduced.

Emergency response expert systems can be divided into two categories according to major function. They are

(1) Those applications that attempt to diagnose faults in a plant under abnormal operation and potentially advise operators on corrective action, and

(2) Applications that classify the abnormal event with the intent of advising third parties (police, county officials, state officials, regulatory officials, etc.) about the potential for offsite consequences.

RSAS falls in the first category. Although EP falls in the second category, it does not specifically determine Emergency Action Level. Both REALM and EM-CLASS fall in the second category.

What is the Emergency Action Level? Emergencies are

classified into one of four categories:

- Unusual Event Events are in progress or have occurred that indicate a potential degradation of the level of safety of the plant. No releases of radioactivity requiring offsite response or monitoring are expected unless further problems with safety systems occur.

- Alert Events are in progress or have occurred that involve an actual or potential substantial degradation of the level of safety of the plant. Limited releases of radioactive material may occur, requiring onsite and offsite radiation monitoring and dose projections.

- Site Area Emergency Events are in progress or have occurred that involve actual or likely major failures of plant functions needed for protection of the public. Substantial releases of radioactive material are likely or actual, but a core melt situation is not indicated based on current information.

- General Emergency Events are in progress or have occurred that involve actual or imminent substantial core degradation or melting with potential or actual loss of containment integrity.

These emergency classifications, also called Emergency Action Levels, communicate the severity of an accident. This provides emergency response personnel with an indication of appropriate offsite actions required to protect the public. This classification scheme is an internationally recognized scale for the classification of emergencies. The objective of both EM-CLASS and REALM is to figure out the appropriate classification for an emergency.

Emergency classification is performed by comparing the current plant state to predetermined criteria to conclude the proper classification. The predetermined criteria are typically presented as a procedure. Due to the nature of nuclear power plants, these procedures can become somewhat complex. At the Trojan nuclear power plant, the procedure is embodied in large, multipage, flowcharts. The outline of Module 2 (Potential Loss of Fission Product Barrier) is provided in Figure 2. In this outline, the boxes labeled "Step n" contain general questions. An example is the following question:

> "Has there been a loss of a single fission product barrier with imminent loss of the second expected?"

General questions allow a plant expert to arrive at the proper emergency classification quickly. The unlabeled boxes that follow the "Step" boxes contain detailed questions. An example of a detailed question is the following:

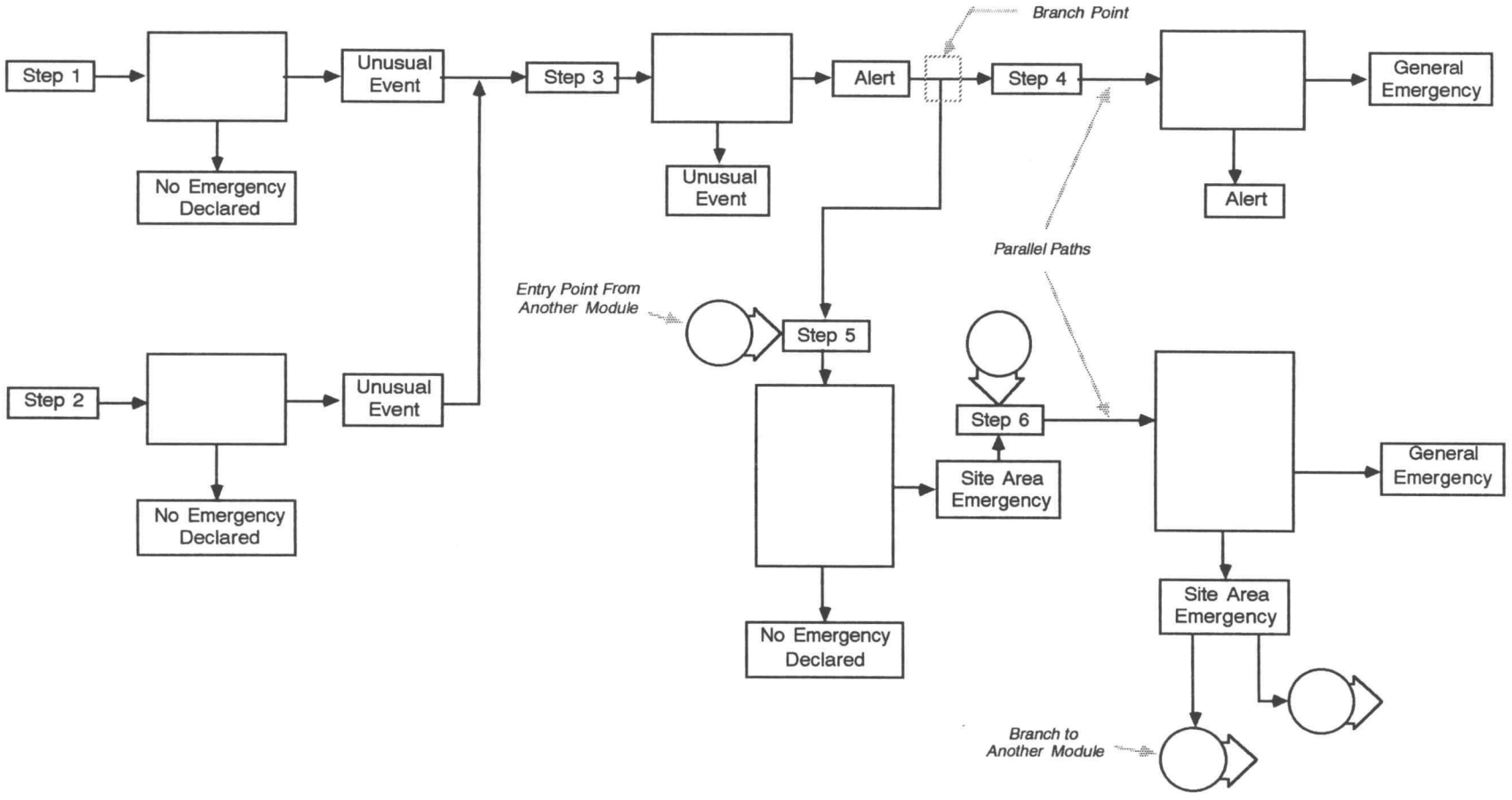


Figure 2. Outline of Emergency Classification Procedure Module 2

"Is PRM-13 reading > 350,000 cpm?"

Detailed questions guide less knowledgeable plant personnel to the proper emergency classification. Figure 2 illustrates some of the complexity that is involved in tracing the logic diagrams. Most of the modules have multiple entry points. All entry points must be traced for applicability, in parallel. Branch points produce additional parallel paths that must be followed. There are also logical connections to other modules that require the tracing of more than one module in parallel. It is not surprising or unexpected that an error could occur when a person tracing the flow chart manually is subjected to the stresses of an actual accident in progress.

The emergency classification procedure for the Trojan Nuclear Power Plant is divided into 15 modules or problem areas. They are

Module 1 Radiological Effluent Release Exceeding Technical Specification Limits

Module 2 Potential Loss of a Fission Product Barrier

Module 3 Steam Line Break or Main Steam Safety or Relief Valve Failure

Module 4 Primary Leak, Primary-to-Secondary Leakage, or Pressurizer Safety or Relief Valve Failure

Module 5 Loss of Power or Alarms

Module 6 Loss of Feedwater

Module 7 Other Limiting Conditions for Operations

Module 8 Reactor Protection System Failure

Module 9 Fuel Handling Accident

Module 10 Control Room Evacuation

Module 11 Fire

Module 12 Security Threat

Module 13 Natural Phenomena

Module 14 External Hazards

Module 15 Internal Hazards

During an emergency, the classification must be updated, as a minimum,

(1) Every 30 minutes

(2) When a significant change in plant state occurs

(3) When a change in emergency management responsibility occurs

The motivation for creation of EM-CLASS was provided by an error committed during an emergency response drill at the Trojan Nuclear Power plant. A few years ago during an annual emergency drill, the Emergency Coordinator (the person responsible for performing the emergency classification function) was in the midst of tracing multiple parallel paths covering more than one module. When referring back to the original module, he turned to the wrong page and therefore produced the wrong classification. An erroneous classification can have serious offsite consequences during an emergency. In addition, an error such as this can lead to undesirable actions by the Nuclear Regulatory Commission. The

misclassification was the result of human error while tracing a complex logic diagram.

2.3. Emergency Classification with EM-CLASS

EM-CLASS is a backward chaining expert system. Therefore, the path to a solution in this search problem begins with the goal. In EM-CLASS, the goal is to establish the value of the parameter STATUS. Because the goal is the Emergency Action Level (the industry term for emergency classification), the values that may be assigned to this parameter are:

"No Emergency Declared"

"Unusual Event"

"Alert"

"Site Area Emergency"

"General Emergency"

Within the context of Personal Consultant™ Plus, the value of STATUS is established with a rule. The goal rule is

```
IF
          FINDOUT 01-RELEASE
     AND  FINDOUT 02-FPBARRIER
     AND  FINDOUT 03-STEAM
     AND  FINDOUT 04-PRIMARY
     AND  FINDOUT 05-POWER
     AND  FINDOUT 06-FEEDWATER
     AND  FINDOUT 07-OTHER
     AND  FINDOUT 08-RPS-FAIL
     AND  FINDOUT 09-FUEL
     AND  FINDOUT 10-CR-EVAC
```

```
        AND   FINDOUT 11-FIRE
        AND   FINDOUT 12-SECURITY
        AND   FINDOUT 13-NATURAL
        AND   FINDOUT 14-EXTERNAL
        AND   FINDOUT 15-INTERNAL
    THEN
        STATUS = (E (SEVERE-CLASS (LIST
                    (VAL1 FRAME 01-RELEASE    )
                    (VAL1 FRAME 02-FPBARRIER  )
                    (VAL1 FRAME 03-STEAM      )
                    (VAL1 FRAME 04-PRIMARY    )
                    (VAL1 FRAME 05-POWER      )
                    (VAL1 FRAME 06-FEEDWATER  )
                    (VAL1 FRAME 07-OTHER      )
                    (VAL1 FRAME 08-RPS-FAIL   )
                    (VAL1 FRAME 09-FUEL       )
                    (VAL1 FRAME 10-CR-EVAC    )
                    (VAL1 FRAME 11-FIRE       )
                    (VAL1 FRAME 12-SECURITY   )
                    (VAL1 FRAME 13-NATURAL    )
                    (VAL1 FRAME 14-EXTERNAL   )
                    (VAL1 FRAME 15-INTERNAL   )))))
```

The Trojan Emergency Plan states that when more than one module is required for an emergency classification, the emergency classification will be the most severe of the classifications that are deduced. Therefore, each module produces a classification. The classification for module 1 (the Radiological Release module) is represented by the parameter `01-RELEASE`. Similarly, the classification for module 2 (the Fission Product Release module) is represented by parameter `02-FPBARRIER`. The `FINDOUT` function in the above rule forces the tracing of the parameter. Because more than one module may be involved in an emergency classification, it is necessary to look at each module. The function `SEVERE-CLASS` is a user defined function, written in Scheme (Texas Instruments, Inc.),

```
(DEFINE SEVERE-CLASS
 (LAMBDA (L)
 (COND
   ((MEMBER "General Emergency"    L) "General Emergency")
   ((MEMBER "Site Area Emergency" L) "Site Area Emergency")
   ((MEMBER "Alert"                L) "Alert")
   ((MEMBER "Unusual Event"        L) "Unusual Event")
    (ELSE "No Emergency Declared")))
```

This function selects the most severe emergency classification from among the modules. It takes one argument, a list of the emergency classifications for each module. The function VAL1 FRAME returns the value associated with the parameter.

EM-CLASS establishes a rule hierarchy to accommodate a range of individuals who would have varying familiarity with the plant and emergency classification procedures. At the highest level in the hierarchy are entry level rules. They represent the classification method that might be used by an individual who, through his familiarity and experience, would determine immediately which modules or problem areas apply to the current situation. The second level of hierarchy adds major rules to the entry level rules. This level in the hierarchy is appropriate for individuals who are sufficiently knowledgeable about the plant to respond to general questions that might be used to determine the appropriate emergency classification. An example of a general question is

> "Has there been a loss of a single fission product barrier with imminent loss of the second expected?"

Finally, the third level of hierarchy contains detailed rules. In

combination with entry level rules and major rules, the detailed rules may aid an individual who is not as knowledgeable about the plant as an expert might be. The detailed rules can solicit basic information related to plant sensor readings and personnel observations. For example, a typical detailed question might be

> "Is PRM-13 (gross failed fuel process radiation monitor) reading > 350,000 cpm?"

2.4. Shortcomings of EM-CLASS and REALM

The objective is to establish an efficient real-time expert system that performs emergency classification at the Trojan Nuclear Power Plant. Two possible approaches to this problem are to use EM-CLASS or to use REALM.

Perhaps the greatest difference between REALM and the EM-CLASS applications is the knowledge domain. Indian Point 2 and several other power plants use an event based emergency classification procedure. Trojan uses a symptom based emergency classification procedure. This difference produces a very fundamental difference in the way expert system technology can be successfully applied to solve the problem. Symptom based emergency classification is most amenable to backward chaining or goal directed inference. The event based emergency classification generally requires forward chaining or data driven inference.

During initial testing, REALM was criticized as slow. It typically took 15 minutes of computation time on the LISP machine to arrive at an Emergency Action Level. Through efficiency enhancements, a substantial reduction in computation time was obtained. For the Indian Point 2 benchmarking test, the average time for classification was 3 minutes but the range was wide, ranging from less than 30 seconds to over 7 minutes. This is much too long to satisfy the needs of the Trojan emergency plan. Two minutes represents an upper limit on providing a classification under some circumstances at the Trojan Nuclear Power Plant.

There are some problems with EM-CLASS. Significantly, when emergency classification with EM-CLASS was compared to emergency classification by manual flow chart tracing, it was found that a competent classifier could easily outperform the expert system. Subsequent investigation determined that much of the information that is required by the expert system is transported by the "tennis shoe" method from the plant process computer to the expert system platform. A better approach would be to provide this information directly to the expert system by electronic connection.

Additional problems are exhibited by the EM-CLASS application. In particular, the user is responsible to recognize

situations that require activation of another module. Some scenarios involve or have potential to escalate to more than one event. For example, loss of multiple fission product barriers is sometimes associated with leakage or loss of coolant inventory. Therefore, whenever the classification for Module 2 escalates to the Site Area Emergency category, some parts of Module 4 must be traced. Finally, the EM-CLASS knowledge representation scheme did not adequately accommodate data obtained from the plant process control computer.

Neither REALM nor EM-CLASS provide the required functionality to perform symptom based emergency classification in a real time process monitoring environment. A new expert system, RT/EM-CLASS is developed to provide this capability.

3. Process Monitoring

A person currently performs the "process monitoring" function by performing an Emergency Action Level classification at regular intervals. By definition, an interval is no more than 30 minutes long and reclassification is required immediately if the plant state changes significantly or if the person designated as emergency coordinator changes. In fulfillment of this task, the operator scans or monitors process instrumentation to maintain situational awareness of the state of the plant. As the situation dictates, he applies the emergency classification procedure to arrive at the proper Emergency Action Level. This process is repeated ad infinitum (or at least until the emergency no longer exists).

Many steps in the process monitoring task can be taken on by a suitably designed knowledge based classification system. This requires extension of EM-CLASS to incorporate features such as retrieving data electronically from the plant process computer and installing a software supervisor to initiate classification at regular intervals.

In his new role, the person would have the current Emergency Action Level available at a glance. Since most of the information required to perform a classification is available directly from the

plant process computer, user interaction with the expert system would be limited to answering a few questions.

Many parameters that the expert system EM-CLASS uses are available from the plant process control computer. By directly connecting this data base to the expert system, substantial efficiency will be realized. Such an implementation would relieve the person from the need to transfer large amounts of plant information from the plant process control computer to EM-CLASS or the emergency classification procedure flow charts.

The process monitoring activity can be automated by extending the capabilities of the EM-CLASS expert system. The system architecture is illustrated in Figure 3. The complete system architecture includes three parts, called processes. The first process, shown as PC+ in Figure 3, is the expert system, EM-CLASS. But, EM-CLASS must be significantly extended so that it may retrieve sensor data from outside the Personal Consultant™ Plus (Texas Instruments) environment, translate the sensor data into the proper knowledge representation, and automatically schedule and conduct consultations. The sensor data as received must be processed to the proper format that is required by the expert system. The software that performs this function forms the second process, labeled DPR. The data is obtained from a computer that contains the sensor data base. Each computer requires hardware and software (e.g., Cross Talk) that permits

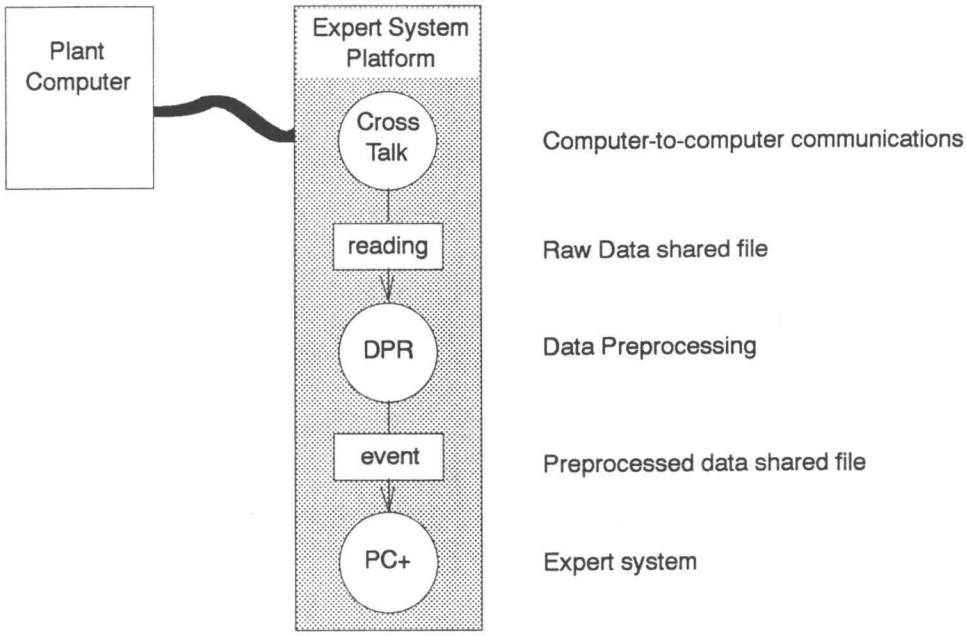


Figure 3. Process Monitoring Expert System Architecture

them to be connected electronically and to pass information between them. Note that the three processes on the expert system platform interact through shared data files.

Several functional capabilities are required to permit EM-CLASS to operate in a real time process monitoring application. These include:

- Develop an automated supervisor to control the consultations.
- Retrieve data external to the EM-CLASS environment.

- Obtain and operate hardware and software necessary to connect two computers electronically.

- From within the EM-CLASS environment, execute an external procedure in the DOS environment, without interruption of the consultation.

- Provide memory management to Personal Consultant™ Plus to prevent memory overflow by retention of out of date data.

- Provide automated process startup feature through macro.

- Implement the minimum necessary data processing or filtering possible. Pass numerical data to the expert system.

- Extend the Online (Texas Instruments) data trending functionality to apply to bivariate data.

- Figure out how to maintain the two level user interface.

- Implement internal data acquisition - define numerical parameters and rules to convert numerical data to an appropriate menu choice.

- Improve the visual display information presentation.

- Develop a user interface appropriate for a real-time expert system.

These capabilities are developed in the sections that follow.

4. Expert System Implementation

The most important feature of the real time emergency classification application is the expert system itself. As a starting point, this is based on EM-CLASS. But major changes in both architecture and knowledge representation are required to adapt EM-CLASS for use in a real time process monitoring environment. The extent of the changes required are illustrated in

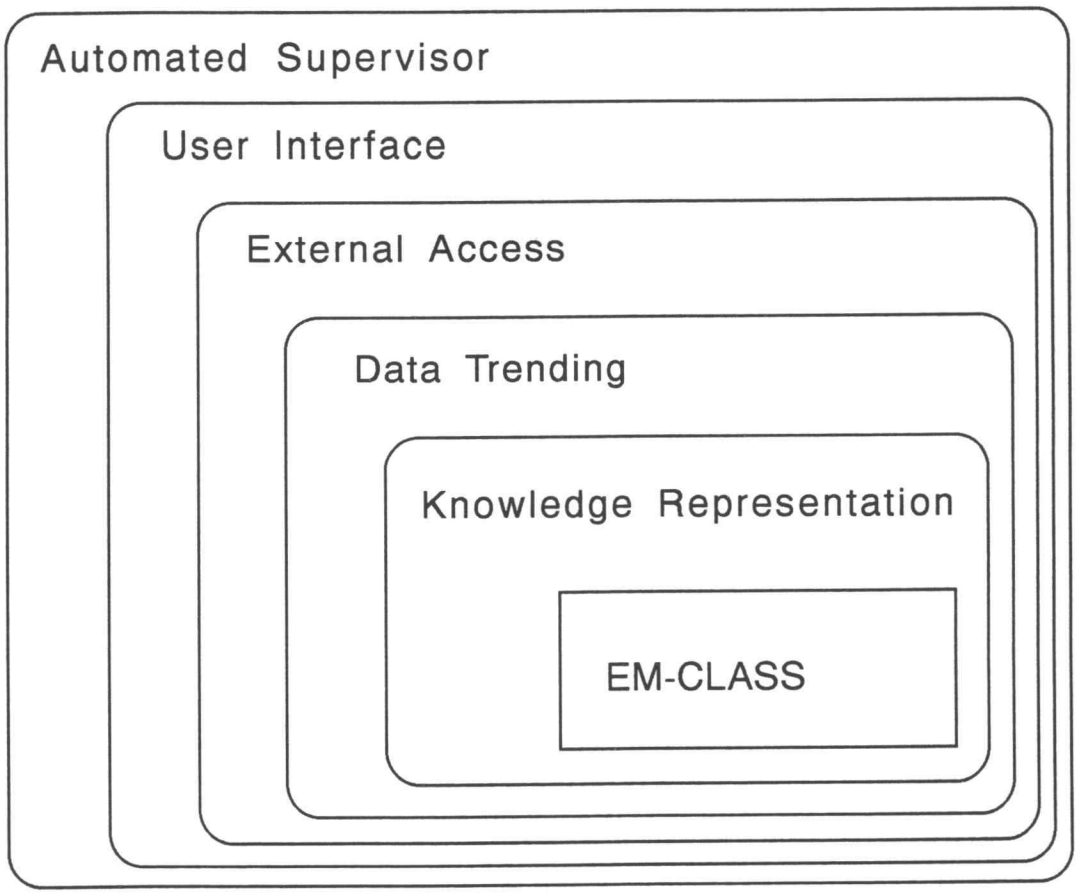


Figure 4. Extending EM-CLASS for Real Time Application

Figure 4. EM-CLASS must be extended to accommodate an expanded knowledge representation scheme, perform data trending, obtain external access to data, provide a better user interface, and conduct automated operation. This section is devoted to the restructure and extension of EM-CLASS for the RT/EM-CLASS expert system.

4.1. Knowledge Representation

One of the most important factors in development of a knowledge based system is knowledge representation. This factor is usually specified early in the development of a system. In EM-CLASS, it was decided that the knowledge should be represented in a way that permits the user, a human, to choose a correct response from a menu of choices. The reason for this choice is the following. Human factors experts discovered that when a person enters information into a computer, the person is less likely to make an error (such as transposition of digits or other keyboard entry errors) if a menu of choices is provided in lieu of numeric keyboard entry. EM-CLASS was designed with a menu driven user interface for this reason. However, this choice for data representation is inadequate when acquiring knowledge electronically from the plant sensors where the data is primarily numerical in nature.

During the initial development of RT/EM-CLASS, the method of

knowledge representation within EM-CLASS was retained without modification. This approach required translation of numerically typed plant data into string typed menu choices externally to the expert system. This translation was performed by a FORTRAN program during the data processing and formatting step. (The DPR process is discussed in a later chapter). This approach significantly increased the complexity of the knowledge based system to the point where it is doubtful it could effectively be maintained once it was placed in service. Therefore, it became necessary to change the knowledge representation scheme within EM-CLASS. Changing the way knowledge is represented so that both types of knowledge acquisition are well supported (human user and electronic) would greatly enhance the effectiveness of this application.

A key feature of the knowledge representation is that it accommodates varied levels of knowledge abstraction. The purpose for using different levels of knowledge abstraction is to accommodate acquisition of factual information from a variety of sources, human and machine. The four levels are [Figure 5]:

Level 4 Problem selection - Most Abstract Level - Factual information acquired from plant experts

Level 3 General information - Moderately Abstract - Factual information acquired from individuals who are very familiar with the plant

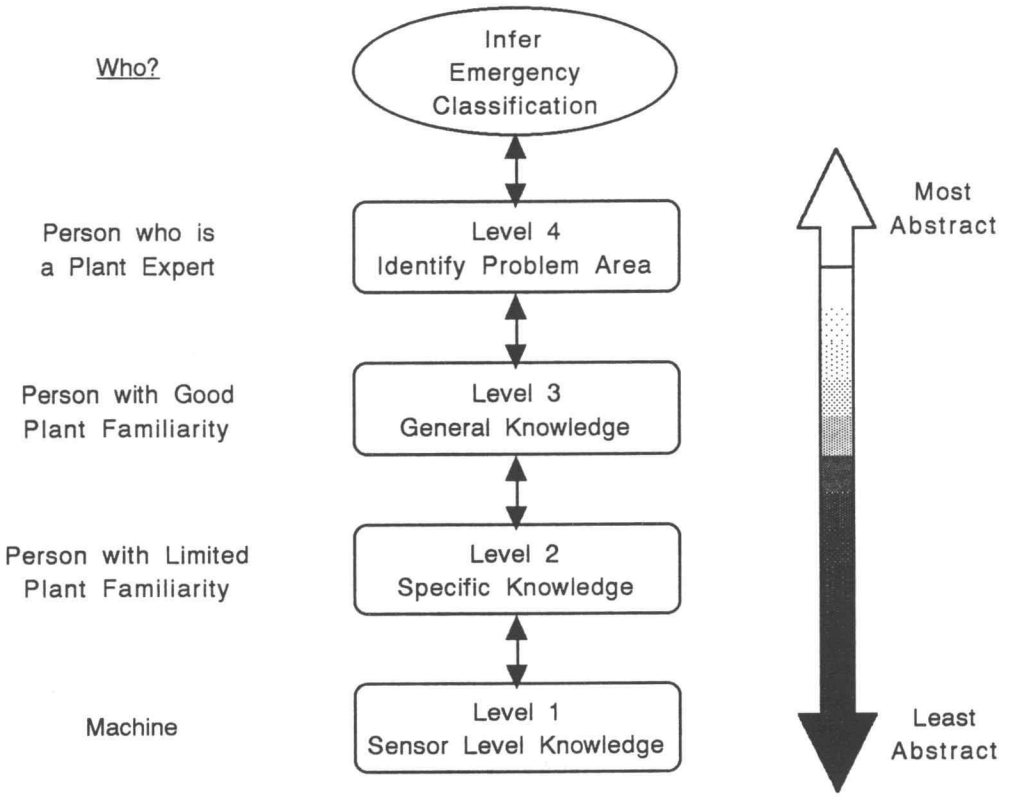


Figure 5. Levels of Factual Knowledge Representation

Level 2 Specific information - Least Abstract - Factual information acquired from individuals who may not be familiar with all the plant systems

Level 1 Knowledge acquired at the sensor level and utilized as numerical information

Facts represented at the sensor level of abstraction are numerically typed. While the information elicited at the sensor level is generally of the same content as the specific information,

the knowledge is represented differently than knowledge that would require interaction with a person, for ergonomic reasons. Facts at all other levels of abstraction are represented as descriptive strings organized into menu selections. Relating factual information between levels 2, 3, and 4 is direct. Inferring level 2 knowledge from level 1 data requires conversion because knowledge representation is necessarily different.

The methodology for data conversion between levels 1 and 2 is best illustrated with an example. Consider the following. One fact that may affect Emergency Action Level is the measurement of auxiliary building low level noble gas. At the Trojan Nuclear Power Plant, this fact is provided by the Process Radiation Monitor identified as 2C (PRM-2C). This fact is provided as a number, for example

$$R1007 = 3.69 \times 10^4$$

with the units of cpm. R1007 is the designation used to identify this sensor at the Trojan Nuclear Power Plant.

If a numerical value is unavailable, the user must be asked for the information. In conformance with the knowledge representation guidelines, when asked to provide factual data on PRM-2C, the user selects from the menu choices,

```
"<4.7E3 cpm"
">4.7E3 cpm, High alarm"
">4.7E4 cpm"
"Off-scale"
```

Facts at a higher level of abstraction are inferred from facts at a lower level through rules. Personal Consultant™ Plus provides as its basic element, the rule form IF...THEN... With this construct, four rules would be required to relate the level 2 menu selection data to the level 1 numerical data in this example. These rules might look like the following:

(1) IF R1007 < 4.7×10^3 THEN PRM-2C = "<4.7E3 cpm"

(2) IF R1007 ≥ 4.7×10^3 AND R1007 < 4.7×10^4
THEN PRM-2C = ">4.7E3 cpm, High alarm"

(3) IF R1007 ≥ 4.7×10^4 AND R1007 < 1×10^6
THEN PRM-2C = ">4.7E4 cpm"

(4) IF R1007 ≥ 1×10^6 THEN PRM-2C = "Off-scale"

It is easy to see how this could become a bit awkward and lead to an excessive number of rules very quickly. The problem with a large number of rules is that it complicates the validation and verification process that is a requirement of most nuclear related applications. If this conversion was made with another high level language such as FORTRAN, the ideal programming construct would be the IF...THEN...ELSE..., which is essentially a multi-conditional rule.

Personal Consultant™ Plus has been extended by defining a multi-condition rule form. This is achieved by defining a function, SELECT-ITEM, written in Scheme. This function is presented in

Figure 6. This procedure is tail recursive (it calls itself with no returned arguments and therefore produces no net CPU stack growth after the first call). A template for use of this function is the following:

IF <sensor-value> IS KNOWN THEN <object> =

(E (SELECT-ITEM <sensor-value> <boundaries> <menu-choices>

where the input arguments are

- The sensor value of the parameter (VALUE)
- The numeric boundaries delineating the categories (SET-POINTS)
- The menu-choices where a value will be placed (ITEM-LIST)

With this function, PRM-2C could be established with the following rule:

```
(select-item
    (LAMBDA (value set-points item-list)
        (COND ((EQ? nil value) ('UNKNOWN))
              ((< value (CAR set-points)) (CAR item-list))
              ((= (LENGTH set-points) 1) (CADR item-list))
              (t (select-item value (CDR set-points)
                    (CDR item-list))))))
```

Figure 6. Multi-conditional Rule Functional Code

```
IF      R1007 IS KNOWN
THEN    PRM-2C = (E (SELECT-ITEM
            (VAL1 FRAME R1007)
            '(4700 47000 470000)
            '(  "<4.7E3 cpm"
                ">4.7E3 cpm"
                ">4.7E4 cpm, High alarm"
                ">4.7E5 cpm"     )))
```

This function reduces the number of rules required to trace the value of the parameter PRM-2C from 4 to 1.

4.2. Data Trending

Data trending is required to determine the Emergency Action Level. For example, Module 1 Step 3 asks,

```
DO PRM levels project dose rates at the EAB of:
    a) >50 mrem/hr whole body for 0.5 hr, or
    b) >500 mrem/hr whole body for two minutes
(or 5 times these levels to the thyroid)
for adverse meteorology
(Pasquill F stability, 1 m/sec wind velocity)?
```

The two intervals of interest for all time-dependent data are 0.5 hours and 2 minutes.

Online offers some functions that are designed to aid in the trending of data for use within a consultation. Trending, as the term implies, means that a knowledge base may deduce conclusions based on time dependent facts.

Unfortunately, Online trending is somewhat limited because the statistical evaluation is single-variate, that is, the

independent variable is merely an index to the data being trended. This approach is too restrictive for our purposes because it requires tightly controlled timing of plant state snapshots.

Therefore, RT/EM-CLASS trending is performed in the following way. For a 30 minute interval, all measurements that were taken in the last 30 minutes are collected into a list. They are then sorted and the minimum value is selected. This value, the minimum level of the parameter during the 30 minute period, is used to decide if conditions posed by a question such as the one above are satisfied. The same procedure is used for the 2 minute interval.

With Online, facts may be collected for trending with the function TREND-PARM. This action is performed just after the data is retrieved from the DOS environment during the initial setup of each consultation. For example

```
TREND-PARM CLOCK 10
```

will add the current value of the variable CLOCK to the other historically retained values. CLOCK is a parameter used to track event times in the prototype. It is used to mark the data. The number 10 denotes the number of most recent values that will be retained for trending. This value should be determined based on the plant data sampling rate by the expert system. The proper number of values to retain is

$$n = INT\left(\frac{1800}{t_s}\right) + 1$$

where t_s is the number of seconds scheduled to elapse between classification frame instantiations. Similarly,

```
TREND-PARM R1003 10
```

adds the current value of variable R1003, the identification of the Trojan plant sensor that is designated PRM-1D, to the historical data. Note that PRM-1D measures containment vent high noble gas.

For a particular parameter, the information associated with trending may be retrieved with the function GET-TREND. The function

```
(GET-TREND CLOCK ALL)
```

returned the following the data for CLOCK at 895 seconds into a sample consultation

```
((10 639.9 1.6244 56.5879 894.5455)
(388. 443. 497. 553. 609. 667. 726. 782. 839. 895. ))
```

Similarly, the function

```
(GET-TREND R1003 ALL)
```

returned the following data for R1003

```
(   (10 320203. 439435. -27782. 195186.)
    (100000. 100000. 10. 1000000. 1000000. 1000000. 10.
        10. 1000. 1000.))
```

Note that the trend data is represented as a collection of two lists. The first list contains single-variate curve fit parameters that Online derives from the data. The second list contains the data values that we wish to refer to.

The data associated with CLOCK are used to decide how many data points make up a 2 minute interval and how many data points make up a 30 minute interval. A user defined Scheme function, called SET-DEPTH, was written to perform this task. This function is listed in Figure 7. It requires two arguments, a list containing clock values and the time interval under consideration. The template for applying this function is

```
(set-depth (GET-TREND CLOCK ALL) < n >)
```

where <n> is the time in seconds that defines how far back in time to retrieve data. An example of the usage of this function is

```
(SET-DEPTH (GET-TREND CLOCK ALL) 120)
```

This function returns an integer; in this example, the number 4.

```
(define set-depth
  (lambda (d-list interval)
    (if (= (length (cadr d-list)) 0)    ;if no data
       (truncate (/ interval 30))
       (letrec ((lyst (car (cdr d-list)))
                (tics (- (car (reverse (car (cdr d-list))))
                         interval)))
          (if (> interval (car (reverse lyst)))
              (truncate (/ interval 30))
              (letrec ((munk-1 (lambda (new-list set-point)
                         (if (< set-point (cadr new-list))
                                  (length new-list)
                        (munk-1 (cdr new-list) set-point)))))
                        (munk-1 lyst tics)))))))
```

Figure 7. SET-DEPTH Function Definition

Having to wait 30 minutes to observe a parameter being set to a value is an unacceptably long time during development of the software. Therefore, provision is made to allow RT/EM-CLASS to operate in one of two modes. These modes are defined by a parameter called OPERATING-MODE and it is placed in the supervisor frame GENERAL. It is defined:

```
TRANSLATION     ::  (operation in simulation/debugging
                        mode)
PROMPT          ::  ("Is RT/EM-CLASS being operated as a
                        simulator for the purposes of
                        development?" )
TYPE            ::  YES/NO
USED-BY         ::  (RULE245 RULE244)
```

When the software is under development, the time required to set a time dependent parameter is reduced to a minimal number of classification cycles.

4.3. Retrieving Data From the External System

An important step in automating the task of classification is developing the means for getting the electronically transferred information into the expert system in a usable form.

At the start of a consultation, certain tasks must be performed. One of these tasks is to retrieve electronically transmitted plant data. If this activity consumes much time it also might be appropriate to advise the user of the status of the consultation.

An ideal method for acquiring plant process data is through the INITIAL-FUNCTIONS property assigned to the frame CLASSIFY. This function describes actions that are performed when a frame is instantiated, but before the goals are traced. An appropriate formulation of INITIAL-FUNCTIONS for data acquisition is the following:

```
INITIAL-FUNCTIONS   ::
        PRINT "Retrieving plant data..."
            AND
        RETRIEVE-SHARED-DATA "event.dat" "event.rd" 50
            AND
        READ-FROM-FILE "event"  CLOCK ED1067 ED1068 F1059
                    F1060 F1061 F1062 MD1073 MD1074 MD1075
                    MD1076 L1048 L1052 L1053 M1000 M1002
                    M1004 M1006 P1001 P1046 P1047...
```

The print statement is used to inform the user of the state of the consultation. The RETRIEVE-SHARED-DATA function is user-written to interface with a shared file EVENT.DAT. It's purpose is to retrieve data from the shared file if it is available. If the file is busy, the function waits for the file to be released. The READ-FROM-FILE function sequentially assigns the data in the file to the parameters listed.

Unfortunately, Personal Consultant™ Plus will fault if the number of items in the INITIAL-FUNCTIONS agenda becomes too large. Therefore, for this application, plant data must be retrieved through rules. An example is RULE 340.

```
RULE340
=======
SUBJECT      ::  PROMPT-CNTRL-RULES
ANTECEDENT   ::  YES
IF           ::  (HEAR-FROM-USER IS KNOWN)
THEN         ::  ((RETRIEVE-SHARED-DATA
                 EVENT1.DAT GROUP1.RD 150)
                     AND
                 READ-FROM-FILE "GROUP1" CLOCK ED1067
                     ED1068 F1059 F1060 F1061 F1062
                     MD1073 MD1074 MD1075 MD1076 L1048
                     L1052 L1053 M1000 M1002 M1004 M1006
                     P1001 P1046...
```

The limitations about the number of items that may appear in the INITIAL-FUNCTIONS of the frame also apply to the THEN property of a rule. Still, we may use as many rules as are necessary to retrieve the sensor data.

4.4. Visual Display

One of the important user interface issues is associated with the video display. The conclusions screen displayed by EM-CLASS [Figure 8] did not adequately and clearly convey the information that RT/EM-CLASS must present to the user. The principal problem is that most of the display space is used for the module by module summary. In practice, only one or at most a few of the modules are used (although which ones cannot be prespecified). The remaining modules clutter the display with largely useless information. Finally, the useful information is printed in small letters at the bottom of the display.

EM-CLASS: Emergency Classification System (Version 2.2)

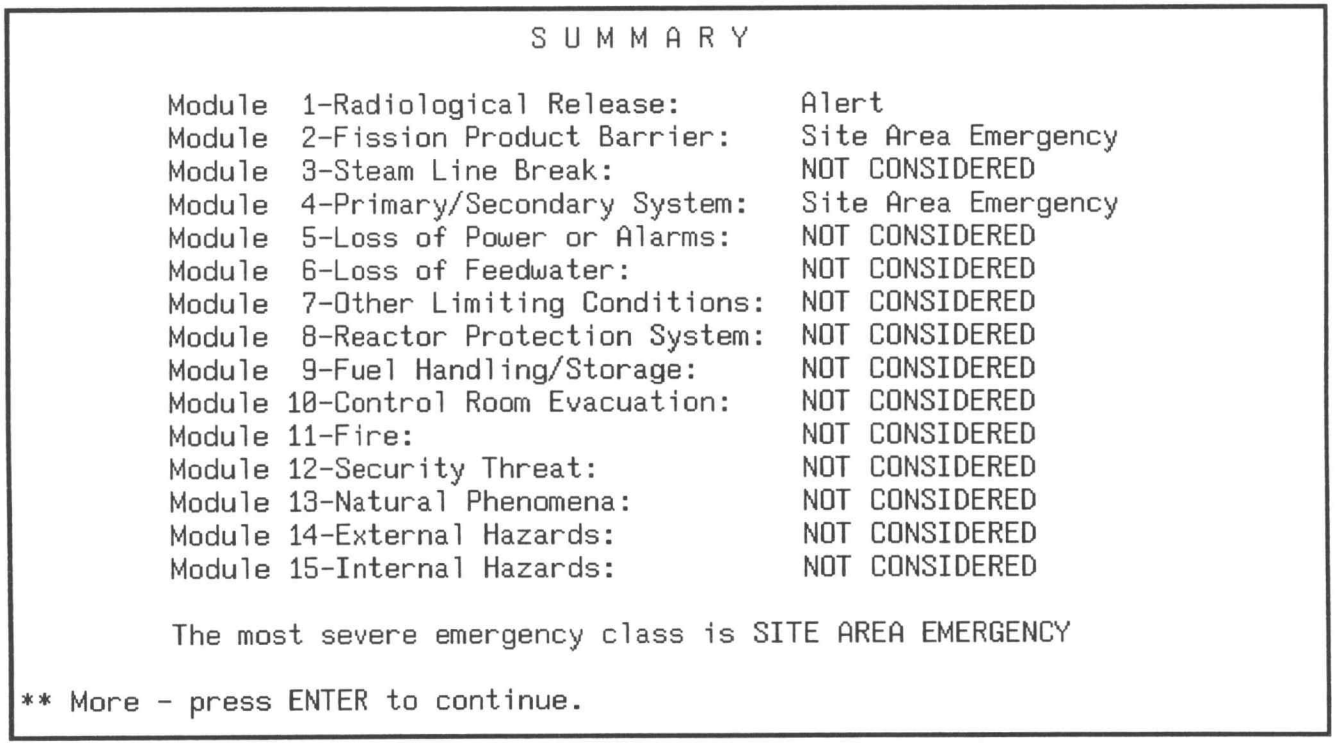


Figure 8. EM-CLASS Emergency Action Level Status Screen

This display has been revised to improve visual effect [Figure 9]. The emergency classification itself is redundantly coded (via color, graph, and text) to avoid confusion and minimize the possibility of observational error. Multiple coding is good ergonomic practice. The redesigned display also provides space near the bottom of the screen for the process DPR to present significant changes in plant parameters.

4.5. User Interaction

Another important issue is how the user interacts with the expert system. Not all the information required for a classification can be obtained from the plant process computer. Therefore, integration of keyboard input facts with electronically acquired facts must be considered. RT/EM-CLASS can to update the classification at approximately 60 to 90 second intervals. The availability of the electronic information makes it desirable to update the classification at this frequency. But, the classification relies on factual knowledge acquired from both the user and the plant computer. Maintaining a reclassification frequency of 30 per hour involves considerable "pestering" of the user. This must be avoided if this system is to be acceptable to the user community. Yet we would like to take advantage of the latest readily available electronic information. The solution is to retain the user responses for reuse. To avoid use of obsolete data, these facts are time stamped. A similar approach was pursued in

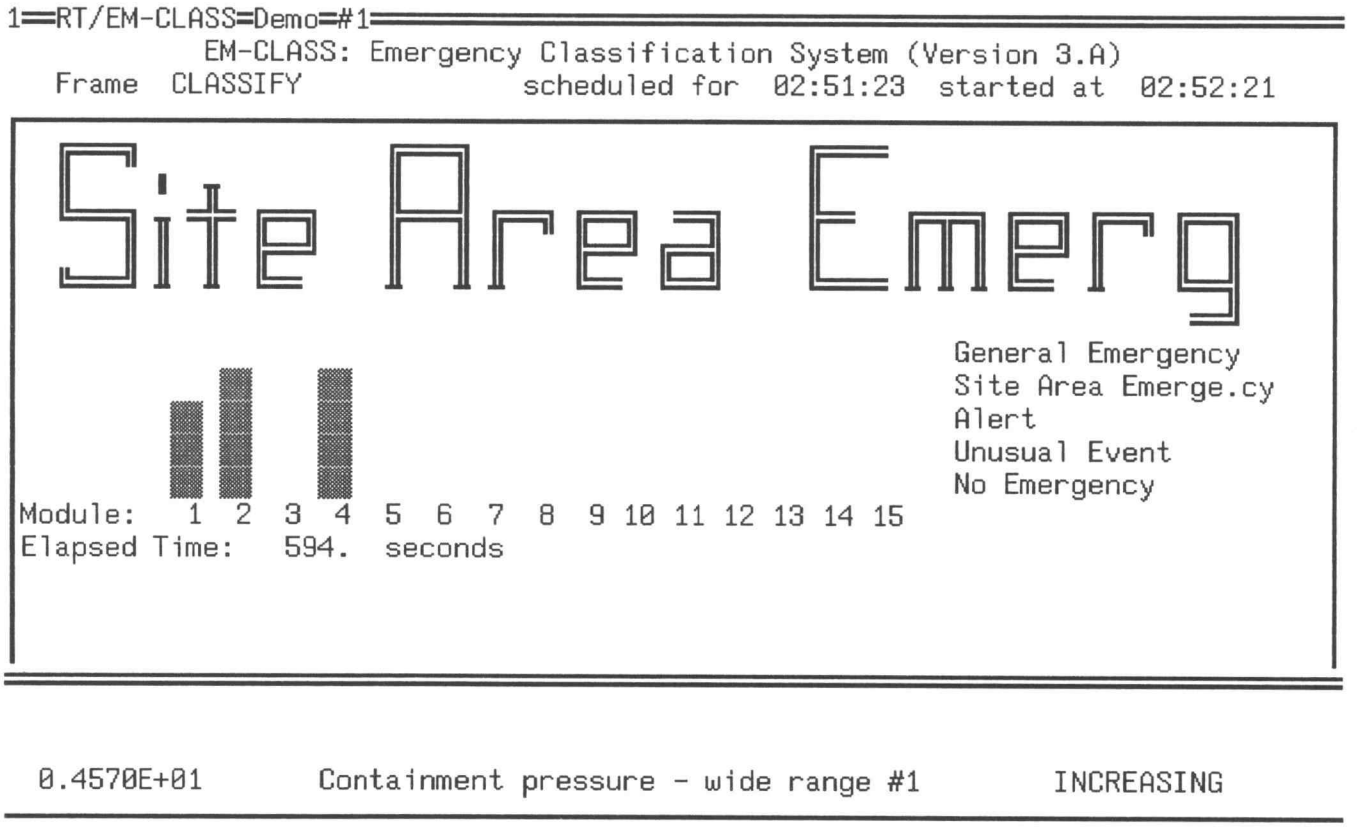


Figure 9. RT/EM-CLASS Improved Display

the RSAS expert system application (Sebo, et.al, 1985). The data is then reused as appropriate for a user specified interval. This interval is never allowed to exceed 30 minutes, the maximum permissible time between classification updates.

In this scheme, all user input parameters are time stamped. All current values of parameters are written out to a virtual file following a consultation. For example, the rule that saves module 1 parameters is

```
RULE304
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 1 User Input Parameters for
                later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE ARM-15-LK EAB-CALC EAB-DOSE
                  EAB-I-131 EAB-LMT I-131 I-131-RLS
                  I-131-RR IV-FTC SGB-RIVER )
```

This rule has an antecedent property because firing is controlled with the premise, DATA-MGMT, a parameter that is assigned a value near the conclusion of the consultation. The Online function TO-STORAGE is applied to save the current values of the listed parameters. Note that only user input parameters are saved. The others are to be retrieved electronically or deduced from available information.

At the beginning of the next consultation, they are read in again as data. For example, the rule that retrieves the data stored

in the above example is

```
RULE294
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 1 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE ARM-15-LK EAB-CALC
                EAB-DOSE EAB-I-131 EAB-LMT I-131
                I-131-RLS I-131-RR IV-FTC SGB-RIVER ))
```

This rule is antecedent because rule firing is controlled by the premise. The parameter HEAR-FROM-USER is tied to the clock and is a function of the user defined parameter lifetimes. The data is retrieved via the Online IMPORT FROM-STORAGE function.

Then the electronically derived plant sensor data is overlaid. Only those values that are legitimate (good data) are overlaid. By time stamping the parameters and correlating them with the module and step that governs the current classification, the most important parameters may be displayed according to how old the data is.

4.6. Formulate Required Expert System Architecture

Formulation of the appropriate architecture is dependent of how the software will functionally behave. EM-CLASS performs emergency classification in a pointwise fashion. To use the EM-CLASS Knowledge Based System in a capacity where data is

periodically gathered from the plant process control computer or other outside environment, it is essential to integrate it with Online, an overlay for Personal Consultant™ Plus. Online provides the functional features used to schedule frame instantiation, instantiate the frame, and delete the frame when the goals have been reached and posted. It also provides functions useful for data logging, saving data for use in another consultation, and some data trending functions.

Some reorganization of the knowledge base is necessary to integrate EM-CLASS with the Online package. A frame (a Personal Consultant™ Plus software element) must be created as a controller for the consultation. This frame is given the name GENERAL. This knowledge base structure change is necessary because real time monitoring of a process requires a supervisor frame that controls the flow of the consultation by instantiation of subframes. The term "frames" refers to the Texas Instruments software element, not to the Artificial Intelligence community definition of frames. All the rules and most of the parameters associated with EM-CLASS were moved into a subframe called CLASSIFY. The only parameter from the original EM-CLASS application retained in the GENERAL frame is TOPICS. The structure is illustrated in Figure 10.

The scheduling and operational tasks associated with the emergency classification are to be assumed by the "automated

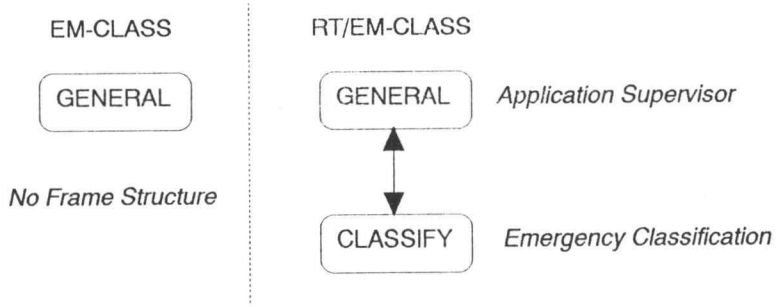


Figure 10. Expert System Frame Structure

supervisor" frame, GENERAL. The consultation mode is set once the value of TOPICS has been determined. This rule is defined

```
RULE232
=======
SUBJECT     ::  GENERAL-RULES
ANTECEDENT  ::  YES
IF          ::  (TOPICS IS KNOWN)
THEN        ::  (SET-OPTIONS NO-PROMPT NO-RETURN-KEY
                     AND
                 FRAME-SCHEDULE CLASSIFY FROM-NOW 0 )
```

The ANTECEDENT property is set so that rule firing is based on the premise (as in forward chaining systems). Two actions are taken by this rule. The NO-PROMPT option disables one means of determining the value of a parameter, namely prompting the user for the value. Many parameters in the RT/EM-CLASS application are available from the plant process control computer. Any parameter that is not known and cannot be determined is marked UNKNOWN when the NO-PROMPT option is set. The prompting function

will now be under the control of the expert system so that factual information may be acquired under controlled conditions.

The NO-RETURN-KEY option disables the prompt for the user to strike the return key when the screen is full. Instead information on the screen scrolls off as new information is added. The purpose of setting this option is to allow the expert system dynamic control of the display. The second action taken by Rule 232 instructs the supervisor to initiate the emergency classification process itself, in other words, instantiation of the sub-frame classify is attempted.

Sub-frame instantiation is conditional. These conditions must be specified as properties of the sub-frame. To begin, a means must be provided to instantiate the subframe on demand to perform an Emergency Action Level classification. This is achieved by assigning the following properties to the CLASSIFY subframe.

```
PROMPT1ST   ::  premise
PREMISE     ::  (TOPICS IS KNOWN)
```

By assigning the PROMPT1ST property the value premise, the means for causing instantiation is shifted from a question directed at the user to the condition listed in the PREMISE property of the frame. Then, once the value of TOPICS is set, the frame will instantiate any number of times as required. But instantiation

occurs only by action from RULE 232 and only if TOPICS has been assigned a value.

At this point, the classification would be performed exactly once. But functionally, what we want to happen is illustrated in Figure 11. Following initialization, the appropriate Emergency Action Level is determined. The results are displayed appropriately for the world. Then, the process is to be repeated, revising the classification as is necessary based on changes in plant state since the last Emergency Action Level determination began.

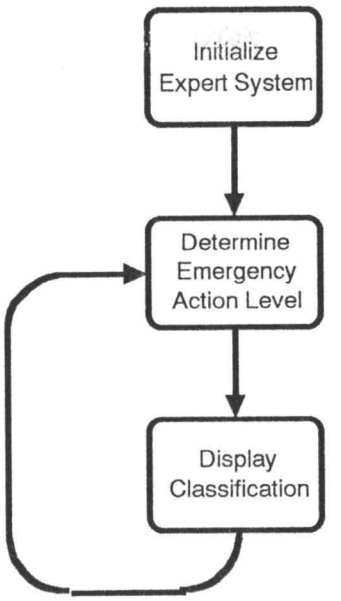


Figure 11. Real Time Repeating EAL Classification

After the results are posted, additional action is required by the supervisor to close the loop. These actions may be summarized as follows:

- Pass a message to the supervisor to schedule the next classification (or consultation)
- Clean up computer memory by removing any unneeded information from the current consultation

These goals are achieved by adding the FINAL-FUNCTIONS property to the CLASSIFY frame. For the RT/EM-CLASS application, it is

```
FINAL-FUNCTIONS
    ::  (FRAME-SCHEDULE CLASSIFY FROM-START 45
            AND
        DELETE-DYN-FRAME FRAME
            AND
        (E (GC #T)) )
```

The FRAME-SCHEDULE function is a message to the supervisor to schedule the instantiation of a frame. In this example, it is to be scheduled to instantiate 45 seconds after the current frame was instantiated.

The next directive is associated with housekeeping on the computer platform. The function DELETE-DYN-FRAME is necessary to avoid overrunning the CPU stack with out-of-date information from previous consultation sessions. In essence, after the conclusions are posted, the information associated with the

current CLASSIFY frame is no longer needed. It is therefore discarded from memory. The last directive forces Scheme to perform a "garbage collection" discarding unneeded symbols and other software elements from memory. Although it is optional, this function is invoked to reduce the variations in execution time while benchmarking the application.

4.7. Missing and Bad Data

It is expected during operation that some data will be missing due to sensor failure or the signal may be bad due to sensor malfunction. The plant computer is expected to assign a data quality tag to each data point.

The easiest way to explain how missing data is handled is by example. The example will be annotated with how the procedure is to be implemented. Suppose the steam line break module has been selected. One indicator of a steam line break is decreasing primary system pressure and temperature. In RT/EM-CLASS, the parameter that contains this knowledge is labeled RCS-T&P. When this knowledge is required to establish an emergency classification and the expert system cannot deduce the knowledge in any other way, the expert system prompts the user with the question

```
"Is reactor primary system pressure and temperature
decreasing?"
```

This is followed by a menu of two options that represent the expected values of the parameter RCS-T&P,

```
YES
NO
```

The user must select one of these choices.

Suppose now that this knowledge is generally acquired electronically (i.e., from the plant computer). Two pieces of information are required: (1) primary system pressure, and (2) primary system temperature. Both are numerical. For the sake of this example, let

P = 2004. psia
T = 540 °F

Two Personal Consultant™ Plus parameters must be created for the two process data values, named, for example,

```
PID-PCS-P
PID-PCS-T
```

The next issue that must be addressed is how knowledge is placed in these parameters.

The values of the electronic sensors are collected in a data file. The format of the values (for the two parameters in this

example) is

```
( 2004. )
(  540. )
```

The data values are acquired by RT/EM-CLASS through the rules during the initial stages of a consultation.

Remember that the objective is to find out the value of the parameter RCS-T&P. Two rules are required to set the value of this parameter based on the knowledge represented by PID-PCS-P and PID-PCS-T. The rules that might apply are:

Rule #1: IF PID-PCS-P ≤ 1950. AND PID-PCS-T ≤ 500.
THEN RCS-T&P = YES

Rule #2: IF PID-PCS-P > 1950. OR PID-PCS-T > 500.
THEN RCS-T&P = NO

These two rules provide the primary means for RT/EM-CLASS to deduce the value of the parameter RCS-T&P. Therefore, it is no longer necessary for the expert system to prompt the user for this knowledge during each consultation.

Suppose that the temperature sensor is not working and no value is provided electronically. How is the knowledge acquired? First, recall that the format of the data file requires that some information be provided for each parameter because the items in the file are position dependent. The way that this situation is

represented in the data file, for example, is

(2004.)
( )

It is clear which information is missing and the parameter position dependence is maintained. Ordinarily, since the parameter PID-PCS-T has not been assigned a value, the expert system would prompt the user for this knowledge. But, the PROMPT property has been removed from the parameters PID-PCS-P and PID-PCS-T. Since the expert system is unable to deduce the value of RCS-T&P from Rules #1 and #2, it will prompt the user for the value of RCS-T&P in a menu as described above.

This procedure is a significant achievement. Not only have the means for handling the missing data been developed, but the menu driven user interface has been preserved. This procedure also significantly reduces the scope of the data reformatting previously required for the electronic data.

This knowledge representation scheme has another benefit also. Suppose that the plant process computer is lost. Should the expert system cease to function properly? The answer is no. RT/EM-CLASS will function effectively with or without the plant computer. The loss of the plant computer will require the user to provide more information to the expert system than might otherwise be required.

5. Preprocessing the Raw Data

The data supplied by the plant computer is not in the format required by EM-CLASS and Personal Consultant™ Plus. Also, the data that EM-CLASS requires will not necessarily correspond on a one to one basis with the sensor data that is available. Therefore, some preprocessing of the raw data will be required.

The software that performs this function is labeled DPR in Figure 3. The scope of action accorded the DPR process has changed considerably since the inception of this project. Initially, the DPR process was used to convert the numerical representation of the plant data into the string representation of facts that are used by EM-CLASS. The problem with doing the conversion external to Personal Consultant™ Plus is that it is necessary to duplicate a large portion of the knowledge base. Although this is not functionally a problem, difficulties associated with increased complexity would occur when the end user is attempting to update the knowledge base. Therefore, the numerical data for most sensors is passed directly to the expert system for internal processing. DPR is currently limited to the following activities:

- Transform sensor readings to Scheme list format
- Filter sensor data that the plant computer labels as invalid

- Eliminate extraneous data
- Track trends in sensor data, posting significant changes
- Translate FORTRAN exponential format to fixed format

The methodology for handling missing data (discussed in the last chapter) uses the Personal Consultant™ Plus function READ-FROM-FILE. This function requires that the data be in Scheme list format, that is, offset in parenthesis (Scheme is the computer language that Personal Consultant™ Plus is written in). A primary function of DPR is to place parenthesis around the sensor values. With respect to data quality, DPR is also responsible for using the data quality labels provided by the plant computer to filter out bad data. This enables the RT/EM-CLASS application to seek other sources for the data.

Another function of DPR is to sort through the many core thermocouples. The expert system is only interested in the five highest reading core thermocouples. The remainder of the core thermocouples need not be passed on to RT/EM-CLASS.

The DPR program summarizes and displays those parameters whose values are changing significantly (currently defined as 5% between two readings). This information is made available to the user to provide credibility to RT/EM-CLASS as it operates in the real time process monitoring environment. Providing credibility for the machine determined Emergency Action Level is important

because the user no longer has control over some of the information the expert system uses to deduce the appropriate classification.

Personal Consultant™ Plus does not recognize the FORTRAN exponential format for number representation. This is most peculiar since Scheme, the language that Personal Consultant™ Plus is written in, does properly handle FORTRAN formatted exponential numbers. DPR is used to do the number conversion.

6. Communication Between Computers

The key to efficient process monitoring with EM-CLASS is getting the plant process data from the plant computer to the classification computer electronically. The prototype requires the ability to transfer information about the nuclear power plant from the plant computer to the computer on which the expert system resides. The software associated with the inter-computer communications process for the machine that contains the expert system is labeled Cross Talk in Figure 3.

A unique feature of the nuclear industry is the influence of regulatory requirements on plant safety. That equipment and computer software that is labeled "Required for Safety" is very expensive. This is so because of regulatory inertia, stringent quality assurance requirements, and the detailed design reviews that are required. "Safety Related" AI applications must provide exceptionally high perceived value to cost to be implemented. Consequently, many good and appropriate applications of AI technology are not being pursued as aggressively as they might be in other industries.

This discussion clearly points out the benefit of avoiding the "Safety Related" label if that is possible and within the scope of the application being developed. For the RT/EM-CLASS application,

the plant data required by the expert system lies on the "Required for Safety" plant computer.

Since the emergency classification itself is not plant safety-related, it is desirable to interface to the plant computer instead up upgrading the development requirements for the emergency classification expert system. Several approaches are possible. With respect to hardware, one way data transmission could be provided through optical isolators using infra-red or microwave transmissions (Blanch, 1986). If a software approach is desired, acquire the data once and then provide the results to all applications that have a need for it. RT/EM-CLASS might be implemented, for example, by tapping the data from the NRC's Nuclear Data Link (Au, 1990). The plant process computer at Trojan is slated to be replaced. The new computer may have the ability to support interfaces to non-safety related equipment.

The mode of connection is expected to be multi-user, i.e., a main-frame computer that services many users. The computer that contains the expert system would use terminal emulation software and be connected through a communications port. This scheme presents an easy implementation vehicle for the EM-CLASS system. The plant process control computer features the ability to communicate through terminal ports. This is the most desirable method for communication.

As part of the coordination of sensor data transmission between computers, some criteria for protocol must be set forth. In this application, for data transmission between computers, the data are to be formatted in label-value pairs. For example,

```
M1002   0.1000E+02
M1004   0.1000E+02
M1006   0.1000E+02
P1001   0.2000E+04
P1046   0.1200E+01
P1047   0.1000E+01
R1002   0.1000E+03
```

The data is to be transmitted in text (ASCII) format to eliminate the need to do computer dependent translations. Although the numerical values are shown here in FORTRAN exponential format, this is not required.

7. Expert System Architecture Management

In general, "... it just ain't worth the cost to duplicate tools that already exist..." (Eliot, 1990). For existing plants and the mature nuclear industry, many analytical tools already exist. Redundant duplication of this effort is not desirable due to the cost that would be incurred. In addition, most applications are written in the most "favorable" environment. The spectrum of environments includes FORTRAN, C, Personal Consultant™ Plus, KEE, Small Talk, and many others. How do you integrate applications from such diverse environments?

The parts that are to form the real time emergency classification expert system have been selected - Personal Consultant™ Plus for the expert system shell, a data processing task written in FORTRAN, and Cross Talk for the intercomputer data transfer. But we are faced with a dilemma. The DOS based computer is setup to run one program or application at a time.

Unfortunately, the shell on which EM-CLASS was developed, Personal Consultant™ Plus and the Online overlay, do not provide sufficient capability to control an environment that contains multiple processes operating in parallel (multi-tasking).

7.1. Multitasking

By multi-tasking (as classically defined; it should not be confused with parallel processing) in the computing environment, existing analytical tools that operate in diverse environments may be used together or integrated. The use of and integration of different environments was demonstrated in the Shuffle PWR fuel shuffling expert system (Greek, 1989). In this application, the computation or problem solution is serial or step-by-step as is conventional programming. It is not part of a dynamic environment where the need to accomplish simultaneous activities of data acquisition and analysis are required. Multi-tasking is necessary for real time emergency classification to integrate the tools.

One could argue that multi-tasking is not necessary for new applications that are created from the ground up. This is true but it involves considerable development cost to write software that might otherwise be available largely complete except for integration in the system of interest. For example, the emergency classification expert system RT/EM-CLASS requires the ability to retrieve data from another computer at arbitrary times. This could be accomplished by writing interrupt driven code that performs the rudimentary functions of computer to computer communication or one could obtain a commercially available program such as Cross Talk (Microstuf, 1983), complete and ready

for integration. Of course, integration under conditions of dynamic system monitoring implies the need for multi-tasking to permit arbitrary data acquisition.

There are several multi-tasking environments. The most common are

DesqView
Unix
VMS

The most appropriate one to use is primarily determined by the hardware and software of your computing system. DesqView is intended for machines which use the IBM personal computer DOS (Disk Operating System). Unix is popular for work stations and is the only operating system that is available for a variety of high end hardware platforms. VMS is the operating system provided by DEC (Digital Equipment Corp.) for use on their VAX family of mini-computers.

The utility Desqview provides the desired multi-tasking capability. The successful implementation of this utility eliminates the need to worry about assembly and machine level coding to handle the interrupts that might be associated with receiving data transmissions at arbitrary times. The CPU time is divided between the applications. It features windowing capability and keystroke macros to aid in management of multiple processes.

7.2. Macros for Software Control

The procedure that was required to setup RT/EM-CLASS and begin execution was initially somewhat involved, requiring the user to complete several tasks according to a prescribed schedule. Since a primary purpose in this work is to reduce the workload of the human who does the classification, this startup procedure is counterproductive. A better method is desired. The startup procedure has been automated with the macro capabilities provided by the Desqview multi-tasking operating system. The macro is shown in Figure 12.

The creation of the macro is simpler than Figure 12 might

```
{Learn {Alt-F12} "!Startup DESQview"}  #Name and assign key

oxt                                    #Connect to plant computer
{Delay 18}or4                          #Open RT/EM-CLASS appl
{DESQ}z                                #Zoom window
{Delay 21}{Enter}                      #Wait for program loading
{Delay 9}{Enter}                       #    ...provide initial input
{Delay 5}{Enter}
{Delay 4}{Enter}
{Delay 2}{DESQ}o2d                     #Initiate DPR processing
{Delay 7}{DESQ}s2                      #Arrange display

{Finish}
```

Figure 12. RT/EM-CLASS Initialization Macro

lead you to believe. Desqview has built-in macro recording capabilities. With respect to creating macros that include the Personal Consultant™ Plus environment, the user should remember that Personal Consultant™ Plus does not store keystrokes typed in advance of the computer prompts. Therefore, timed delays must be built into the macro.

The macro is saved as a Desqview startup script. Sometimes it is desirable to use Desqview with objectives other than the execution of RT/EM-CLASS. Therefore, the following DOS batch file, GORT.BAT, has been created to initialize and execute RT/EM-CLASS from the DOS environment outside Desqview.

```
cd \dv
copy \pcplus\greene\script.irt desqview.dvs
dv
erase desqview.dvs
cd \
```

RT/EM-CLASS may now be started with a single command or keystroke. Alternatively, this batch file could be placed in the AUTOEXEC.BAT file if the platform is dedicated to emergency classification.

The improved display (described in Chapter 4) identifies modules by number. Some users cannot relate the number back to the module description. Therefore, a macro has been developed to aid in this identification. It is accessed via the keyboard by

pressing ALT and F9 successively. The macro opens a window on the desktop and displays the descriptions of the modules by number [Figure 13]. After a predefined delay, the window goes away, restoring the display. The file ENVRNMNT.BAT is a file containing an ANSI escape sequence that sets display attributes.

```
ECHO OFF
call envrnmnt
ECHO Mod  Description                    Mod  Description
ECHO  1   Radiological Release           9   Fuel Handling Accident
ECHO  2   Loss of Fiss. Prod. Barrier    10   Control Room Evacuation
ECHO  3   Steam Line Break               11   Fire
ECHO  4   Primary System Leak            12   Security Threat
ECHO  5   Loss of Power or Alarms        13   Natural Phenomena
ECHO  6   Loss of Feedwater             14   External Hazard
ECHO  7   Other Conditions              15   Internal Hazard
ECHO  8   Reactor Prot. System Failure
```

Figure 13. Help With Module Descriptions
(File MODULE.BAT Without ANSI Escape Sequences)

8. Testing the Expert System

A simulator will be necessary to model the Trojan plant process computer for the purposes of setting up inter-computer communications. This function is performed by another desktop computer.

The simulator works in real time. Elapsed or relative time is used to describe the simulated transient that is taking place. Elapsed time is defined to be the difference between current clock time and the clock time when the simulation was started. This definition was necessary to permit the simulation to be performed independent of wall clock time, primarily for the purposes of development.

There are a couple ways to create delays necessary for the real-time prototype environment. One way is to execute a FORTRAN DO loop for several cycles. While simple to implement, it is difficult to calibrate because execution times can vary widely when operating under a multi-tasking environment. A better method is to tie the delay to the wall clock and to have the user prescribe the time (in seconds) in the file DTIME.PRM. The program DELAY.FOR was written for this purpose. One of its features is that a message displaying the amount of time left is displayed on the screen to inform the user of the status of the

process. The dynamics of this message provides an indication that the system is functioning properly during the intervals of time between display updates.

8.1. Modeling Plant Processes

The performance data for the plant sensors is placed in the SENSOR.DAT file. Note that the symbol $ separates the data for each sensor. Consider for example the sensor data describing RCS pressure, Figure 14. The four lines of data describe the sensor reading as a function of time. These values are linearly interpolated to obtain the correct sensor reading at the current elapsed time. The number of entries describing the behavior of the

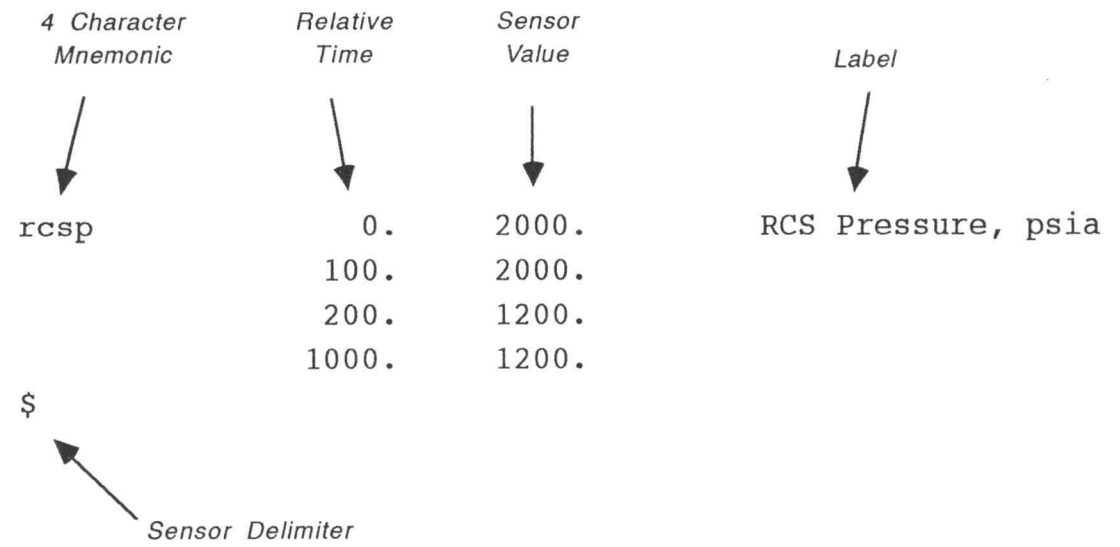


Figure 14. Plant Sensor Dynamic Model

sensor is arbitrary but a minimum of two points are required for interpolation/extrapolation purposes. The sensor reading, during the transient, is shown graphically in Figure 15.

8.2. Benchmarking

The expert system has been tested with a demonstration of the 1988 Trojan Emergency Exercise. Due to the length of the exercise (about 5 hours), the exercise was scaled such that 1 minute of demonstration is equivalent to 15 minutes of exercise. The demonstration therefore takes 20 minutes. In addition, due to the time scale compression, the user inputs must be automated for the simulation to function properly.

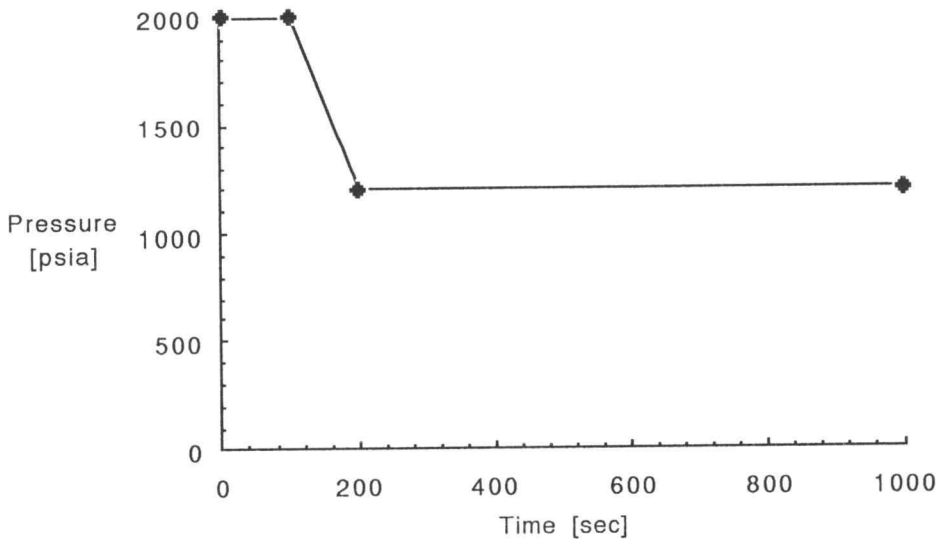


Figure 15. Sample Pressure Sensor Simulated Response

The simulation begins at a wall clock time of 0800 (0 seconds in simulation time). As the scenario begins, the plant is near the end of cycle. Two days ago, an increased count rate on PRM-13 (failed fuel monitor) was observed. This led to collection of an RCS (Reactor Coolant System) sample. A laboratory analysis showed that 0.06% of the fuel has failed. Once additional electrical capacity was made available, it was decided to shut the reactor down early. The plant is currently at 20% power and shutting down at a rate of 5% per hour. At the start of the scenario, another RCS sample is undergoing analysis.

The scenario unfolds according to the following schedule:

Clock Time	Simulation Time (s)	Event
0800	0	The exercise is initiated.
0815	60	The RCS sample shows that failed fuel is increasing at a rate of 0.2%/hr. Declare Unusual Event based on Module 2.
0845	180	A waste gas surge tank pressure excursion occurs. The relief valve opens. Following the pressure spike, the valve fails to reseat, remaining stuck 1/4 open.
0847	188	PRM-2C (Auxiliary Building Noble Gas) reaches a count rate of 50,000 cpm which is more than 10 times the Technical Specification Limit. An Alert is declared based on Module 1.
1000	480	The release stops when the tank has been depressurized. The valve then reseats properly.

1005	500	The RCP B (Reactor Coolant Pump for Loop B) Seal #1 leakage pegs high. Seal #2 hangs open when compensation is attempted. The pressurizer level begins to decrease noticeably. A LOCA (Loss of Coolant Accident) is in progress. A Site Area Emergency is declared based on Module 4.
1045	660	The primary coolant system leak rate reaches 500 gpm. This leakage has caused significant fission product accumulation in the containment sump. Due to a failure in the component cooling water system, containment cooling capability is lost.
1145	900	The steam generator manway for loop C blows out venting to containment. The pressure in the containment is increasing. A General Emergency is declared based on Module 4.
1155	940	A RCP impellor seizes. The shaft does not undergo torsional failure as designed. The pump explodes penetrating the containment. A General Emergency is declared based on module 2.

The displays produced by RT/EM-CLASS are shown in Figures 16 to 31. The expert system called for a declaration of Unusual Event at 72 seconds. Since the expert system produces classifications at a frequency of approximately one per 70 to 90 seconds, this declaration exactly matches the scenario time for declaring Unusual Event of 60 s. RT/EM-CLASS declares an Alert at 200 s. Again, the declaration matches the scenario time of 188 s. The expert system declares that the Emergency Action Level should be Site Area Emergency at 594 sec. This time is within one

cycle of the time the scenario calls for a declaration of Site Area Emergency. RT/EM-CLASS produces a classification of General Emergency at a scenario time of 1069 sec. Again this is within one cycle of the time that the scenario calls for a declaration of General Emergency.

Based on this simulation, RT/EM-CLASS produces the proper classification at the proper scaled time (within the length of time required to conduct a single consultation).

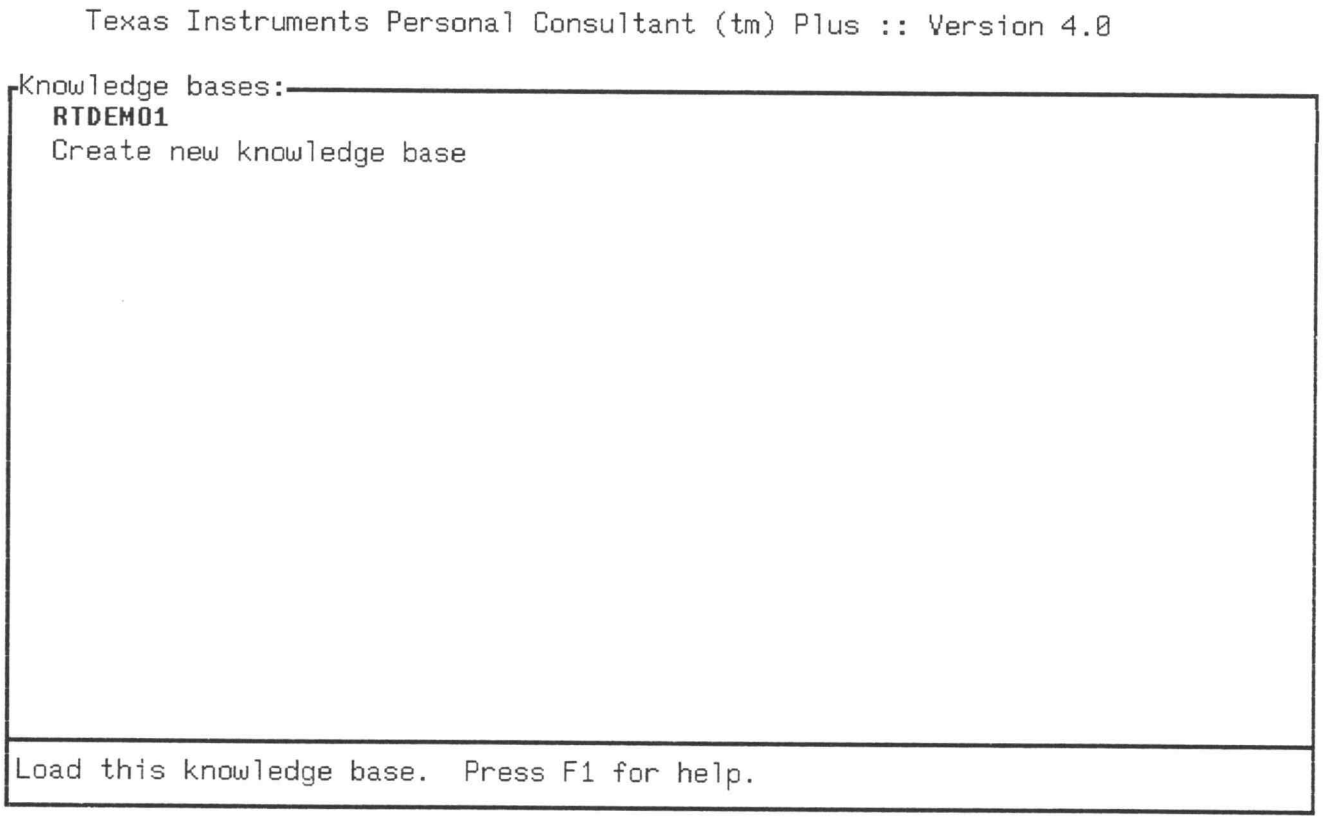


Figure 16. Knowledge Base Selection

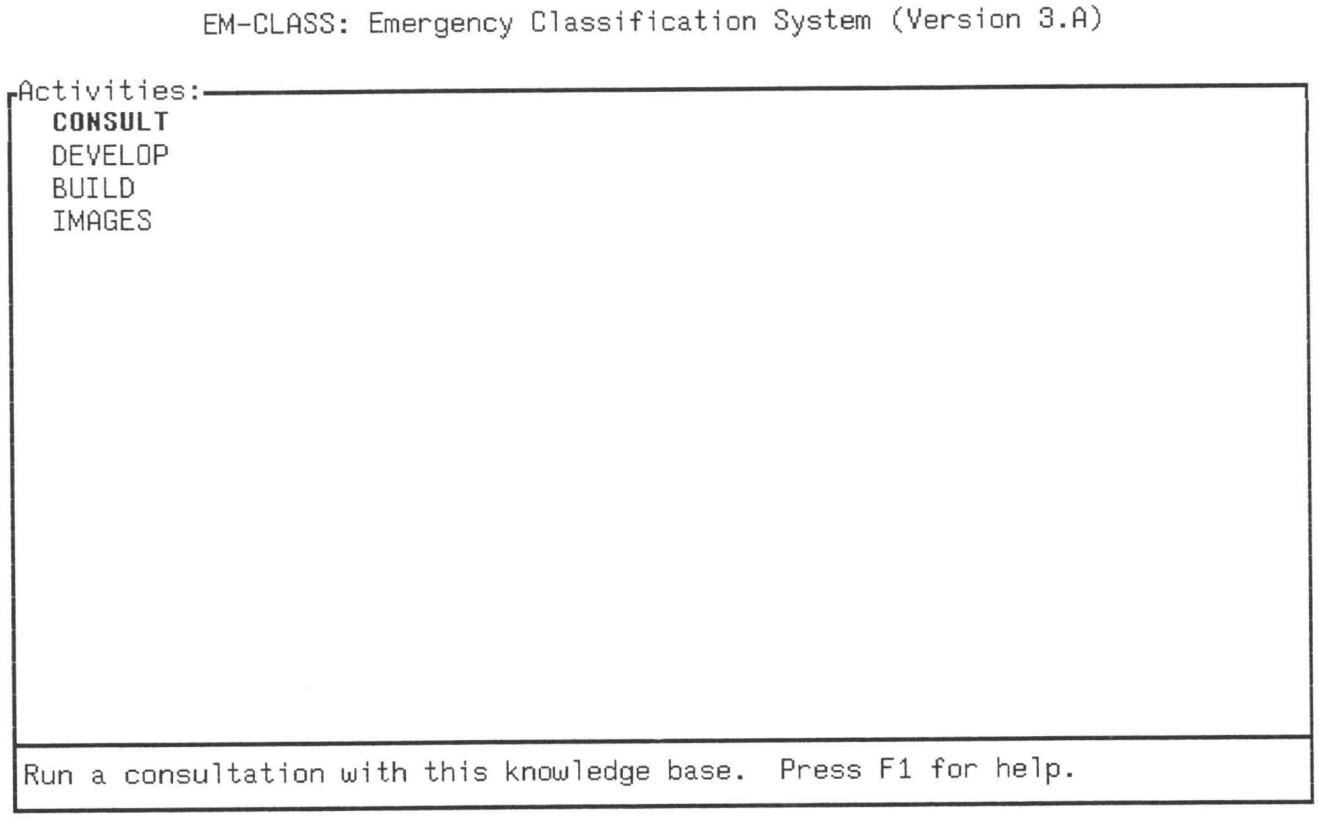


Figure 17. Activity Selection

RT/EM-CLASS: On-line Emergency Classification System

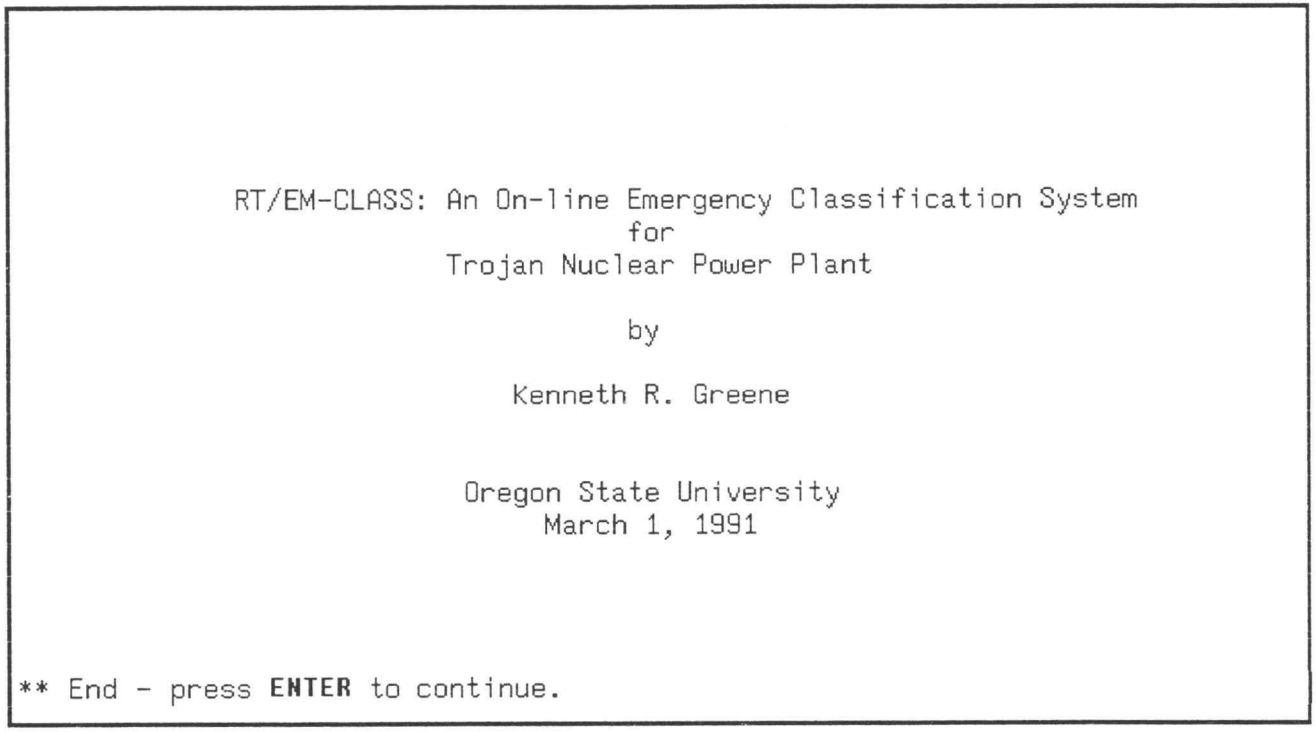


Figure 18. RT/EM-CLASS Title Screen

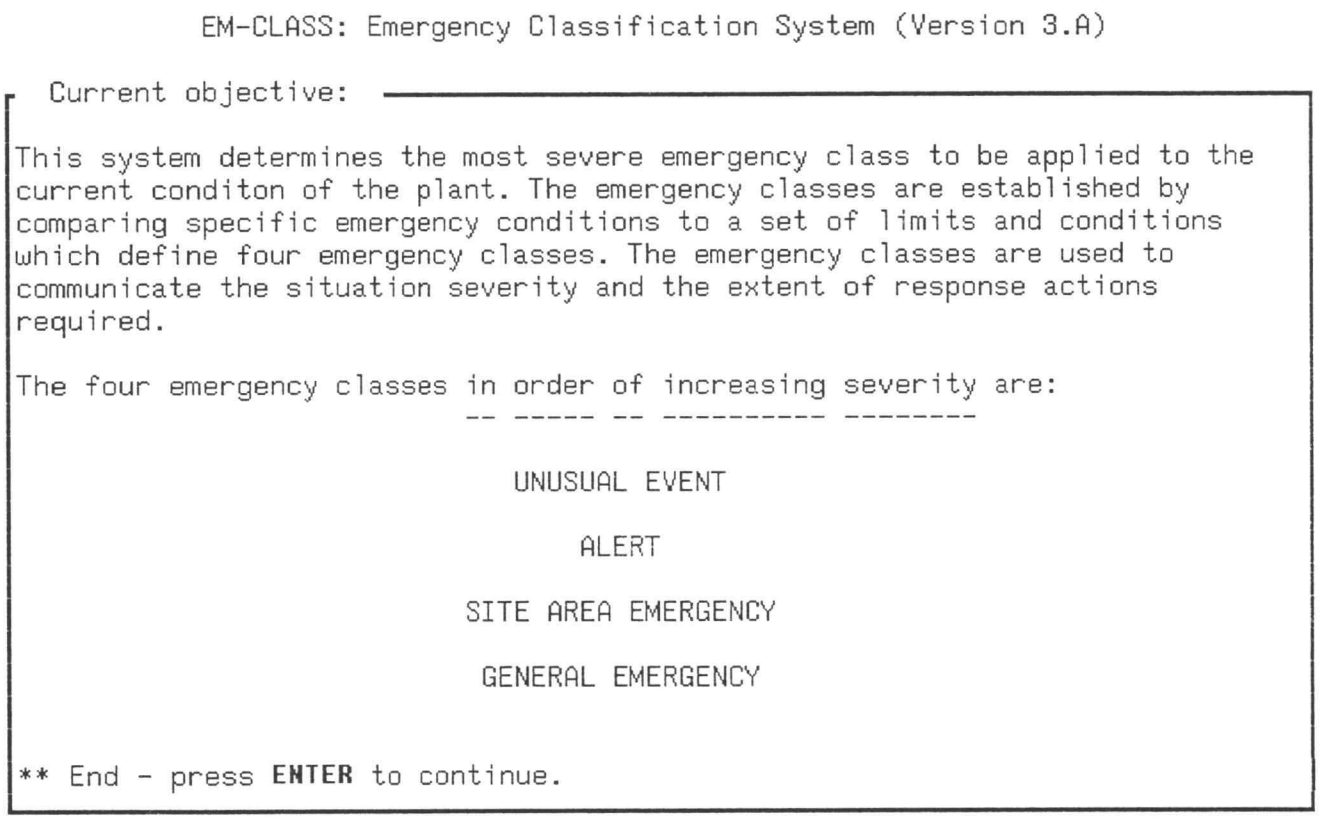


Figure 19. RT/EM-CLASS Objective

EM-CLASS: Emergency Classification System (Version 3.A)

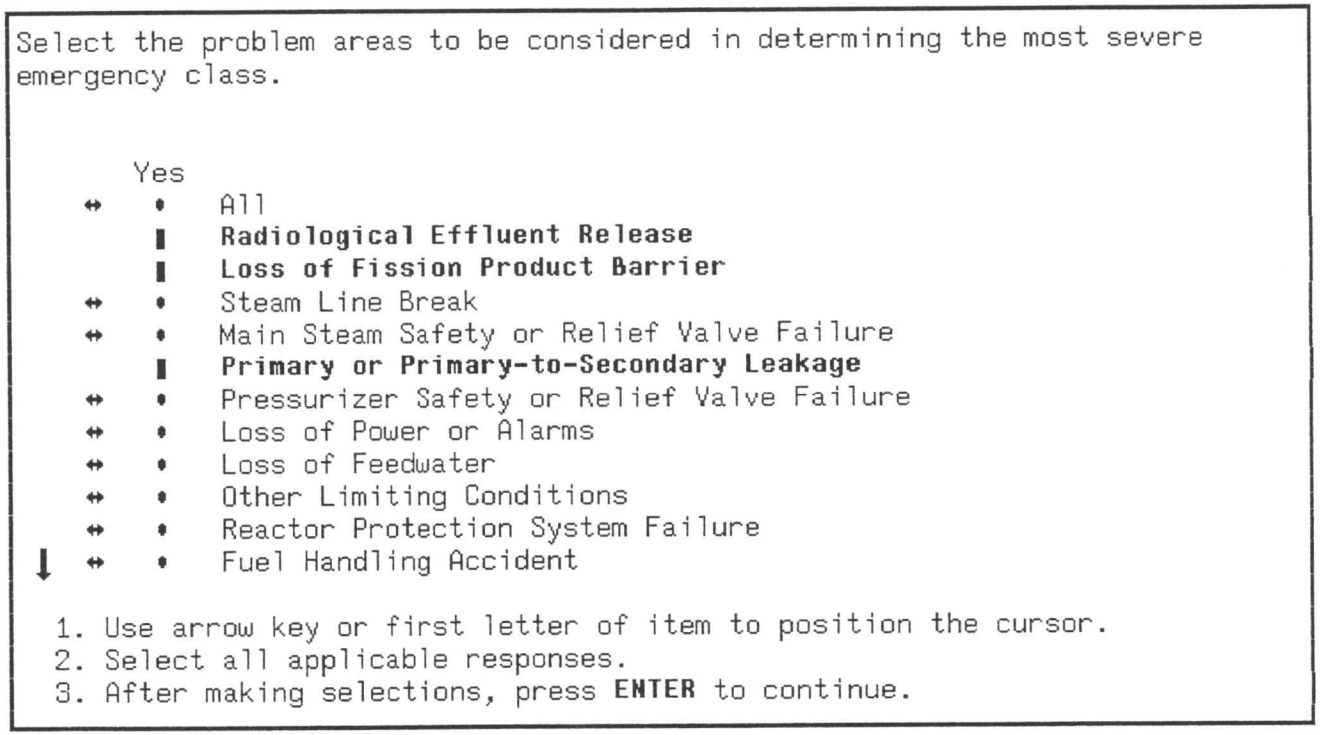


Figure 20. Relevant Problem Area Topics Selection

EM-CLASS: Emergency Classification System (Version 3.A)

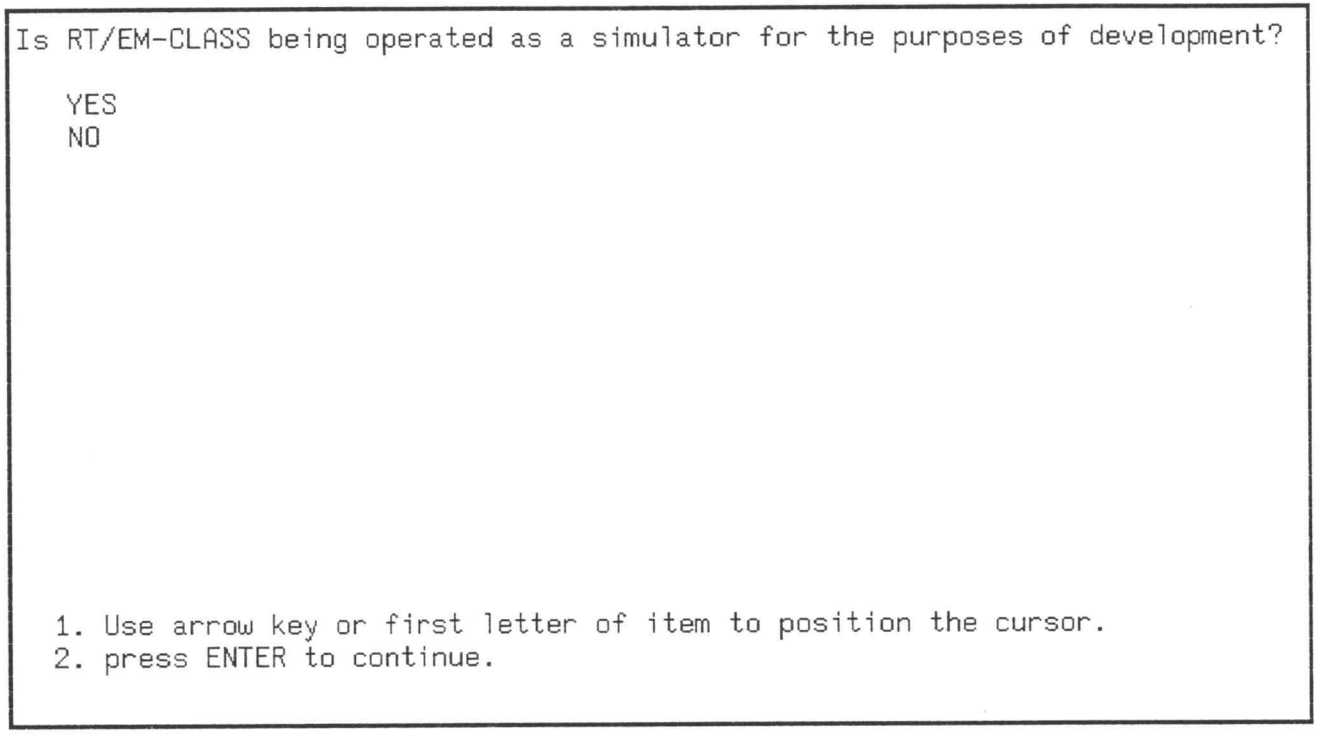


Figure 21. Operating Mode Selection

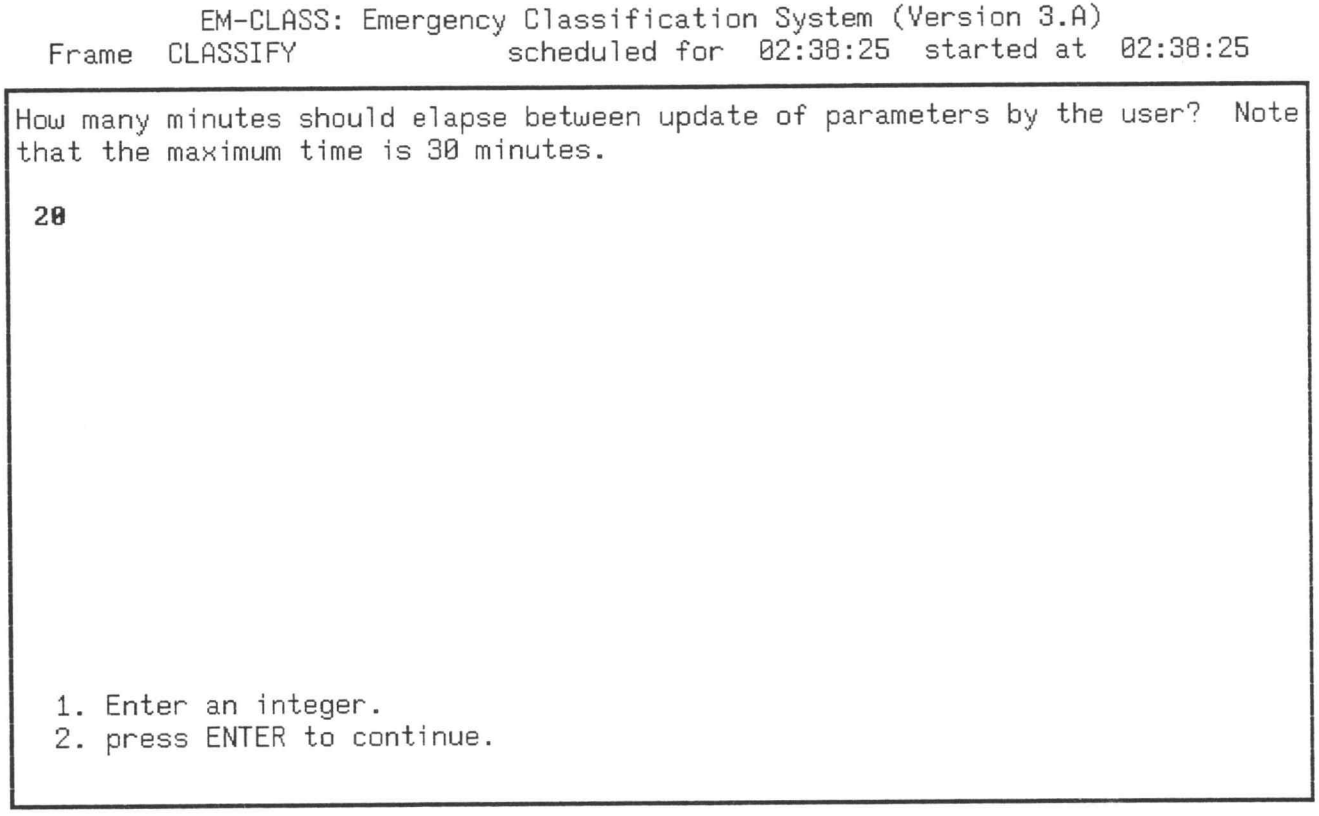


Figure 22. Parameter Lifetime Selection

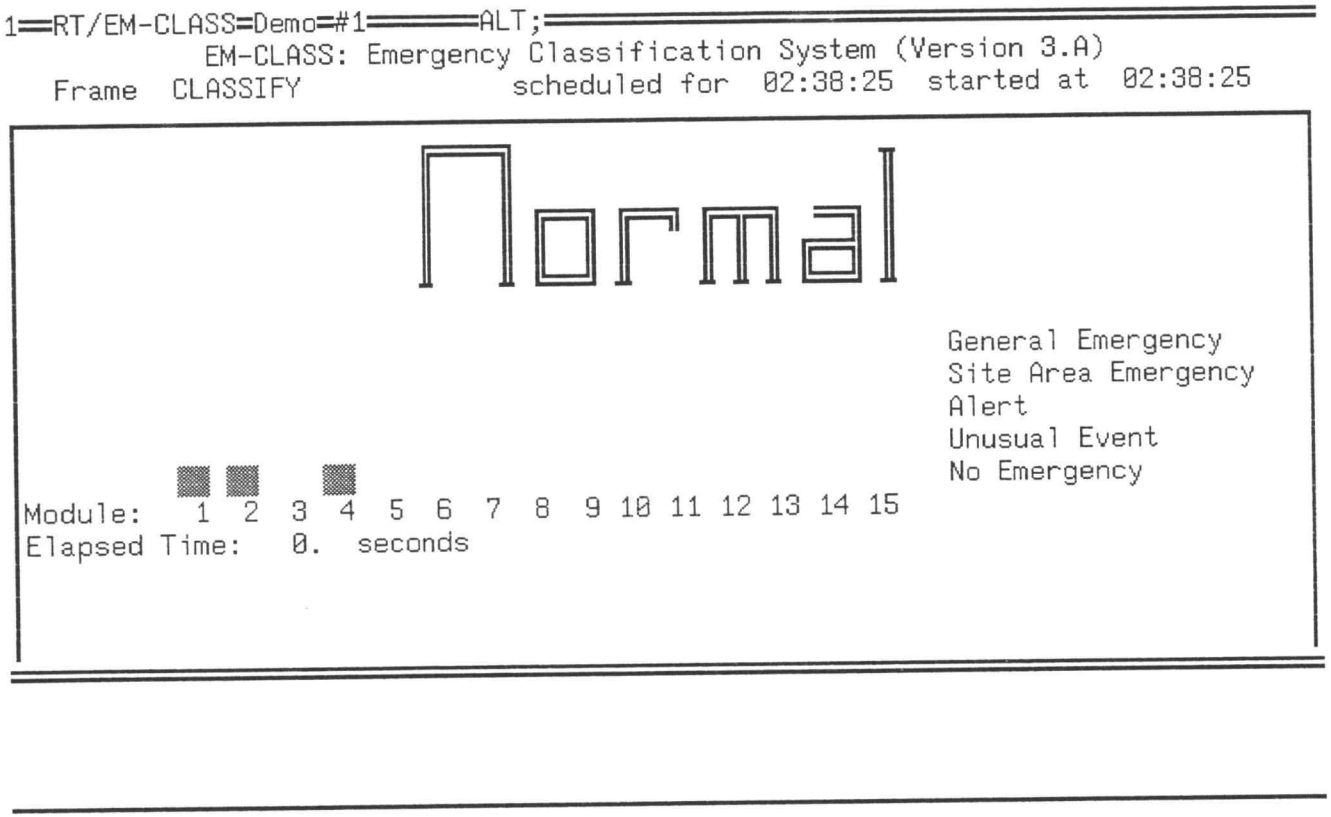


Figure 23. Scenario EAL at Time = 0 sec

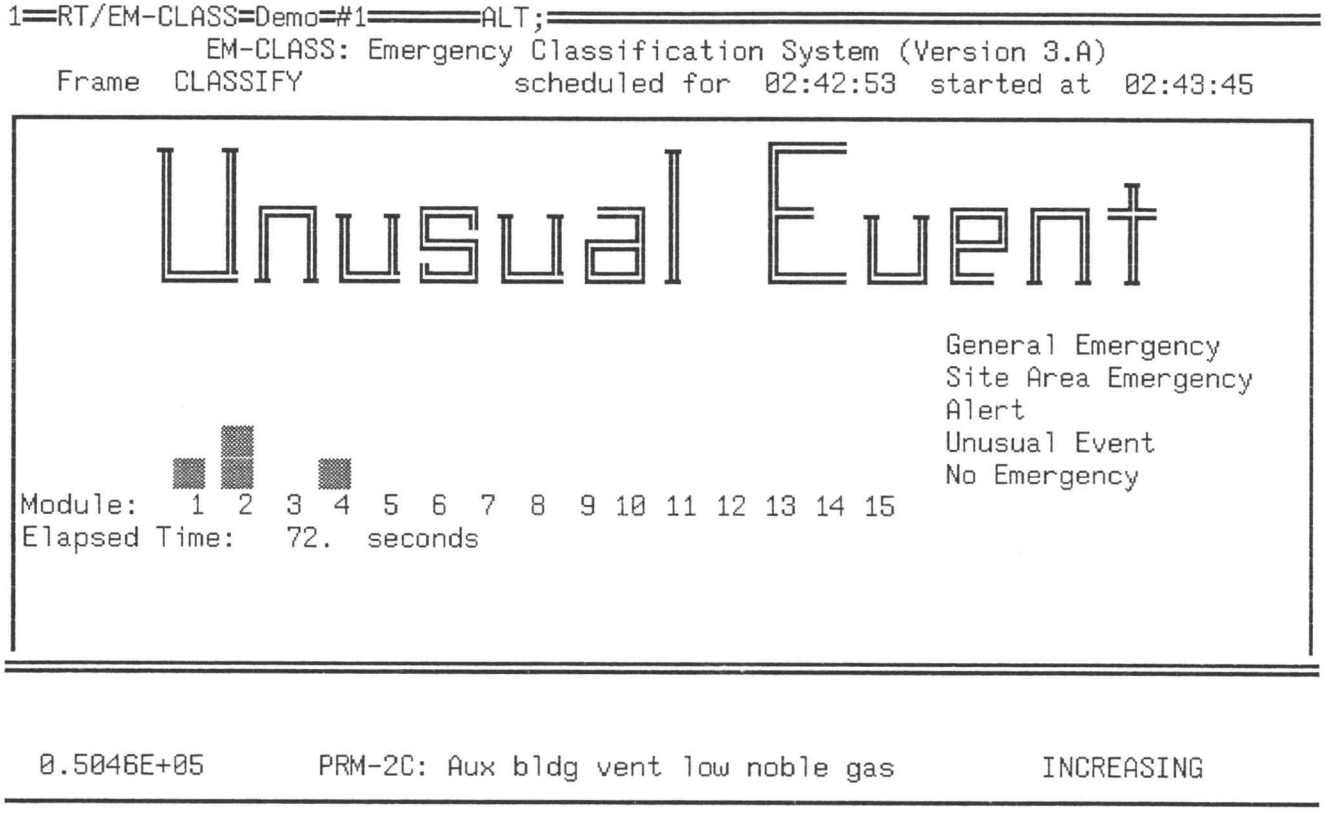


Figure 24. Scenario EAL at Time = 72 sec

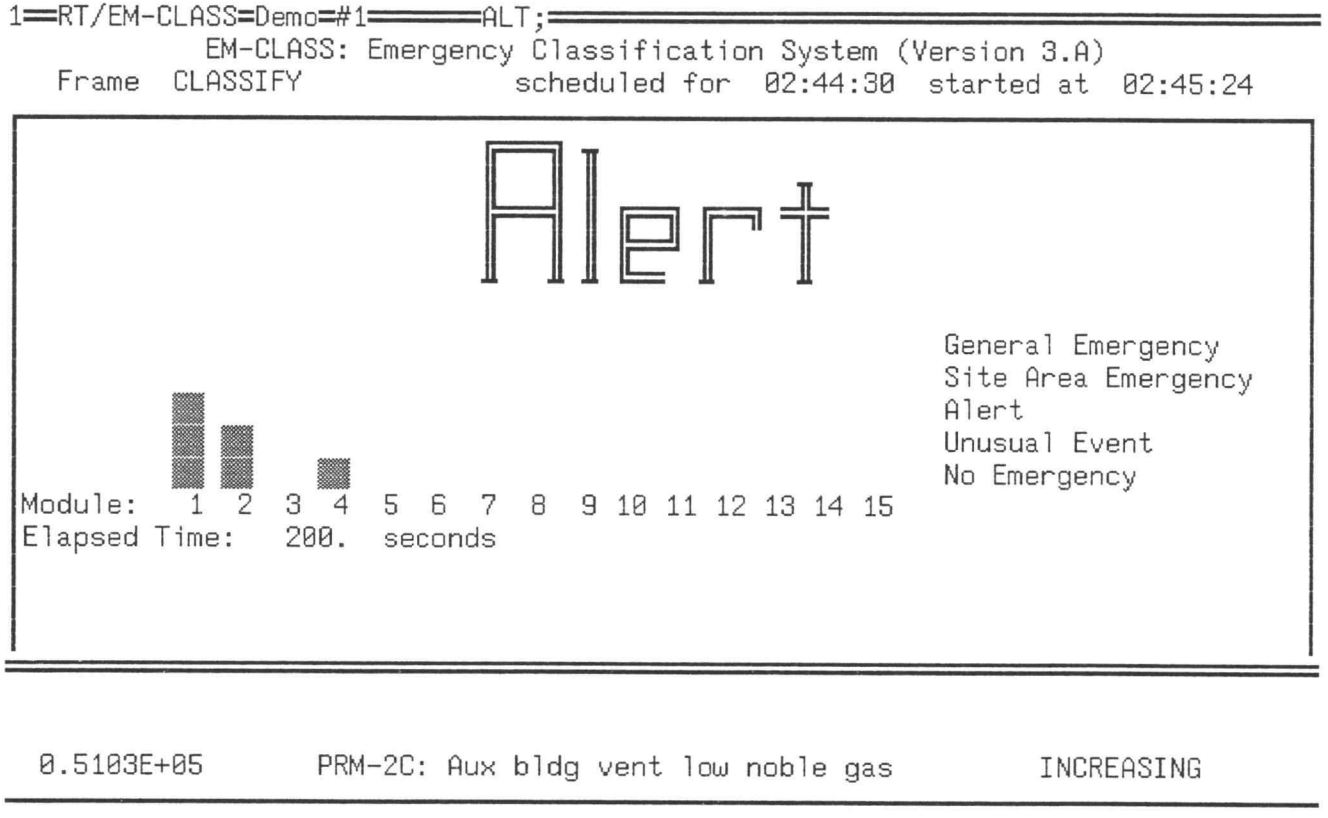


Figure 25. Scenario EAL at Time = 200 sec

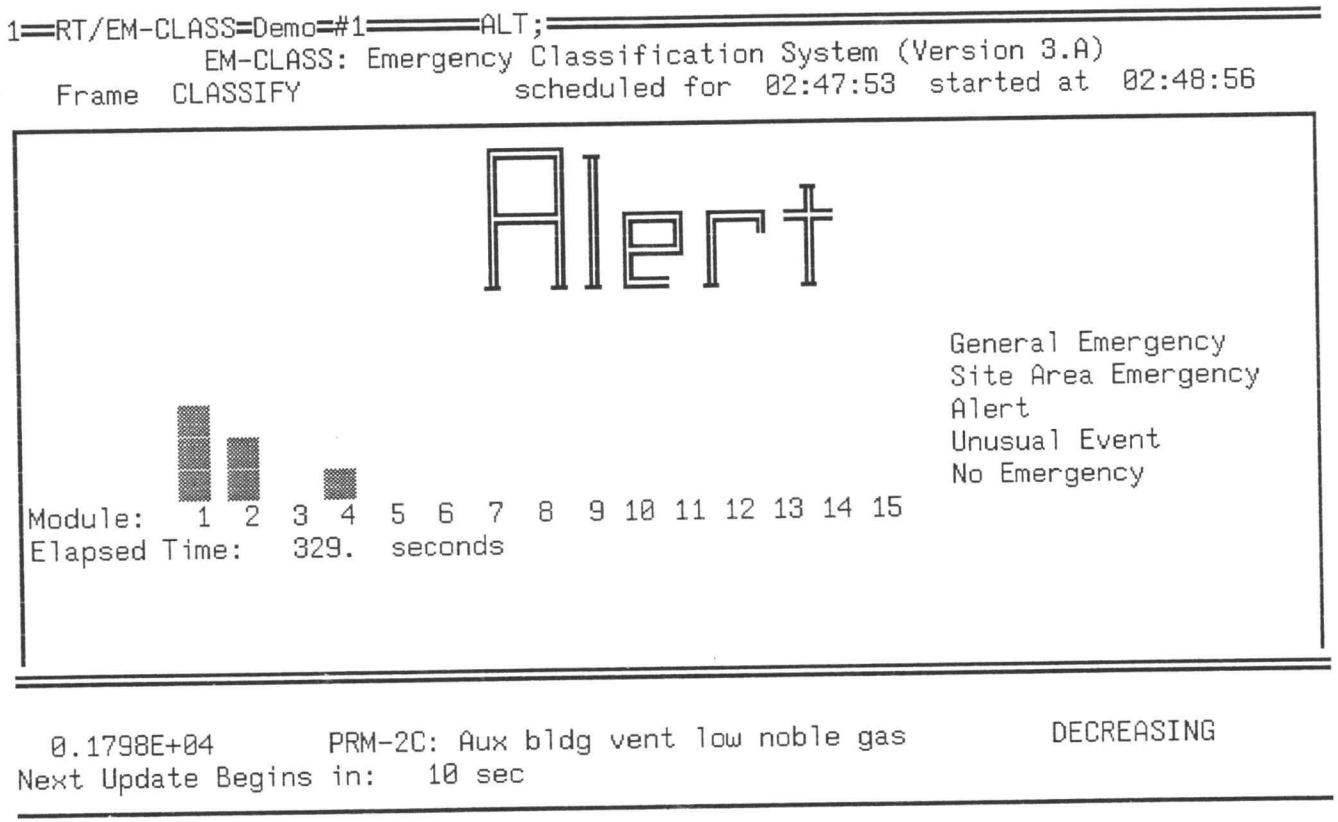


Figure 26. Scenario EAL at Time = 329 sec

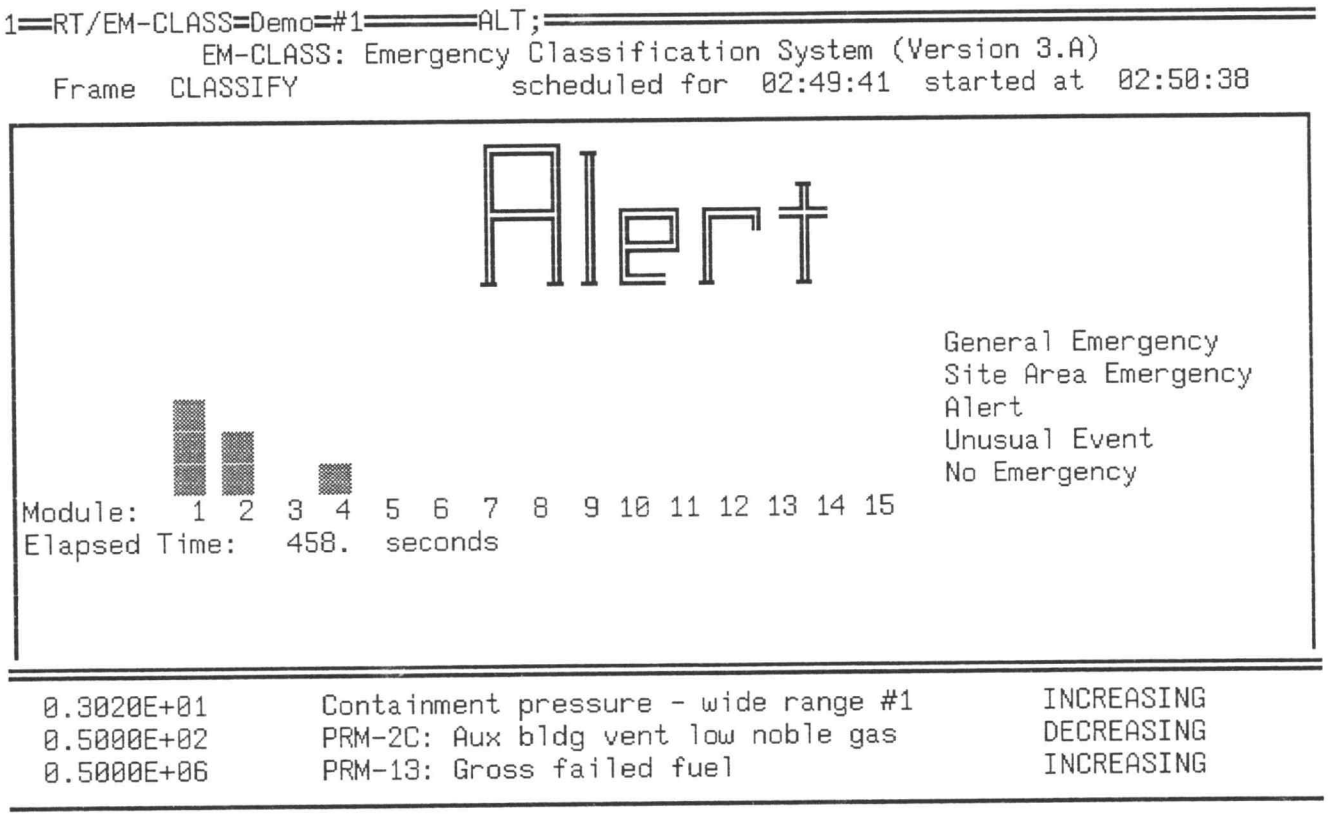


Figure 27. Scenario EAL at Time = 458 sec

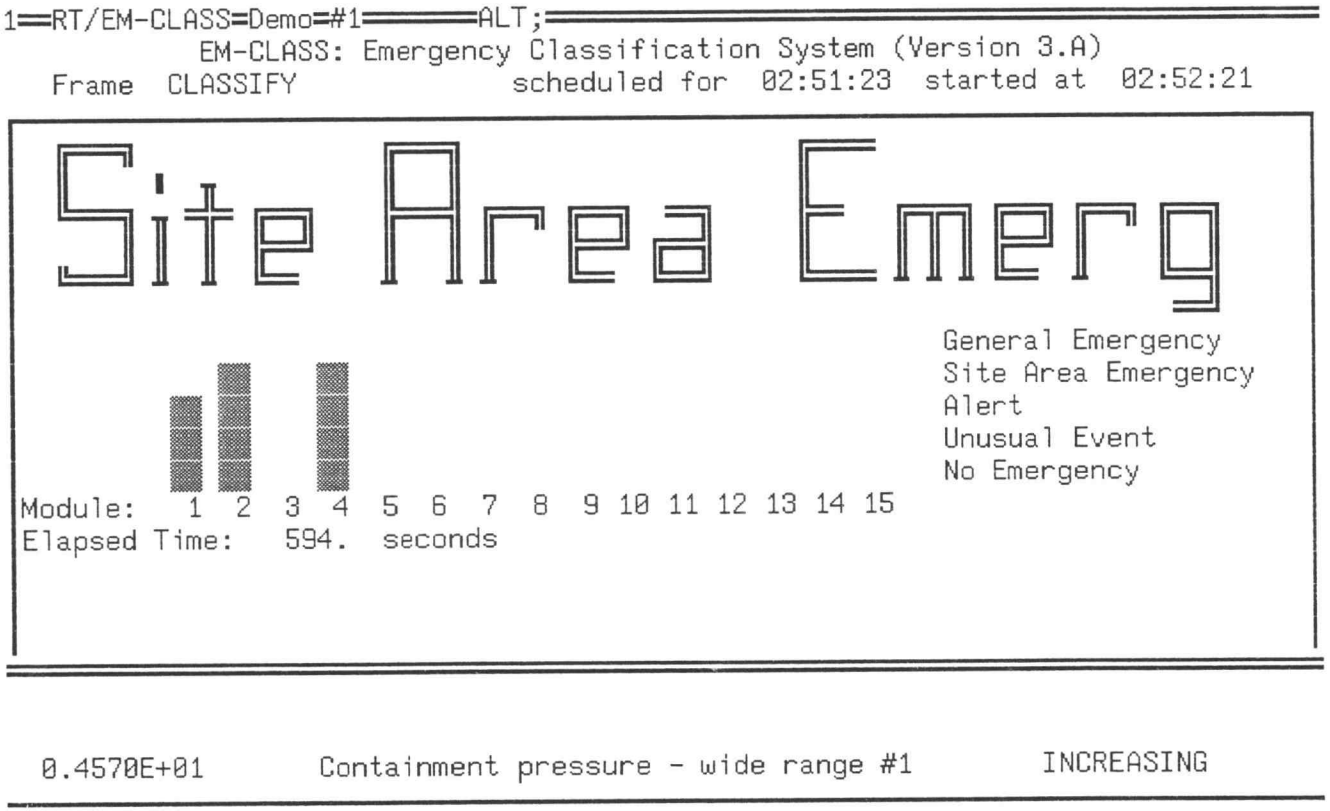


Figure 28. Scenario EAL at Time = 594 sec

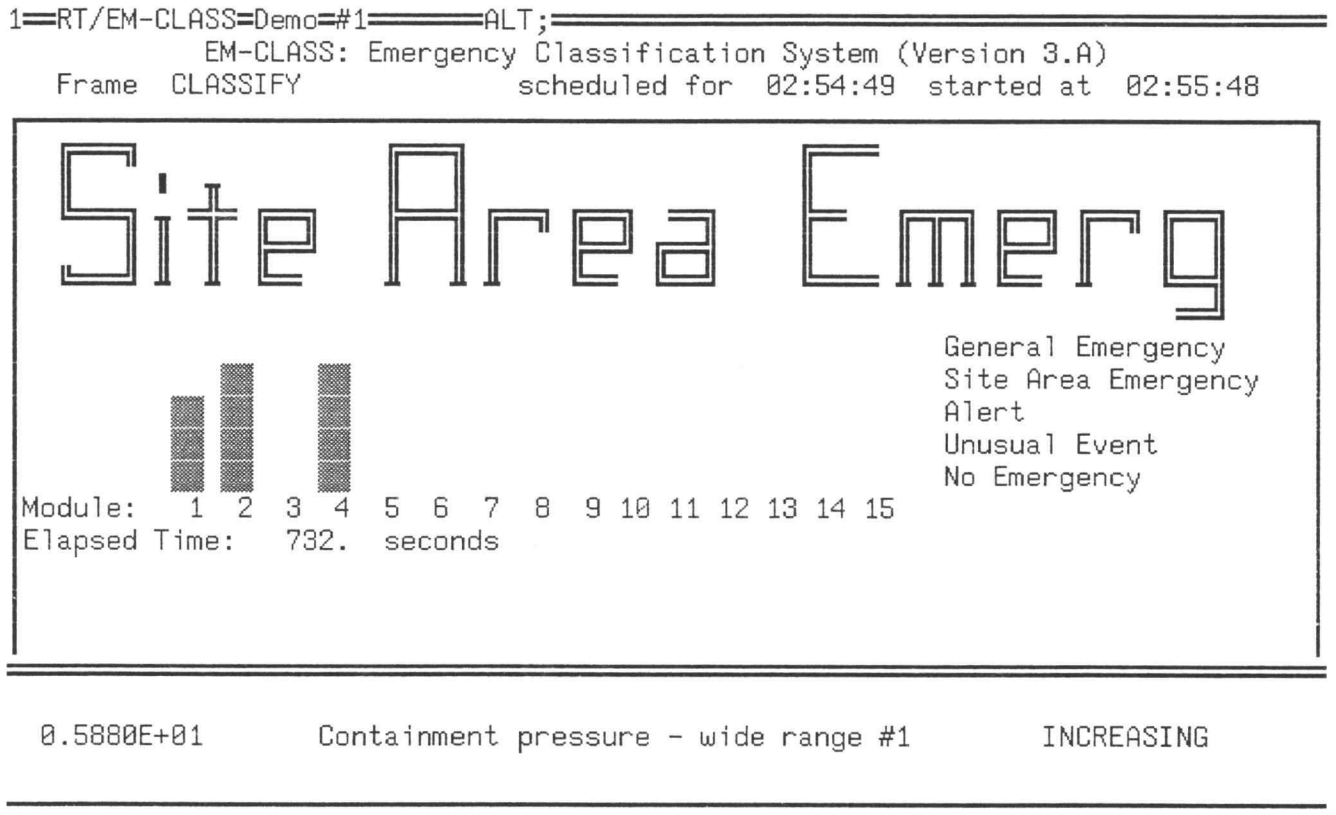


Figure 29. Scenario EAL at Time = 732 sec

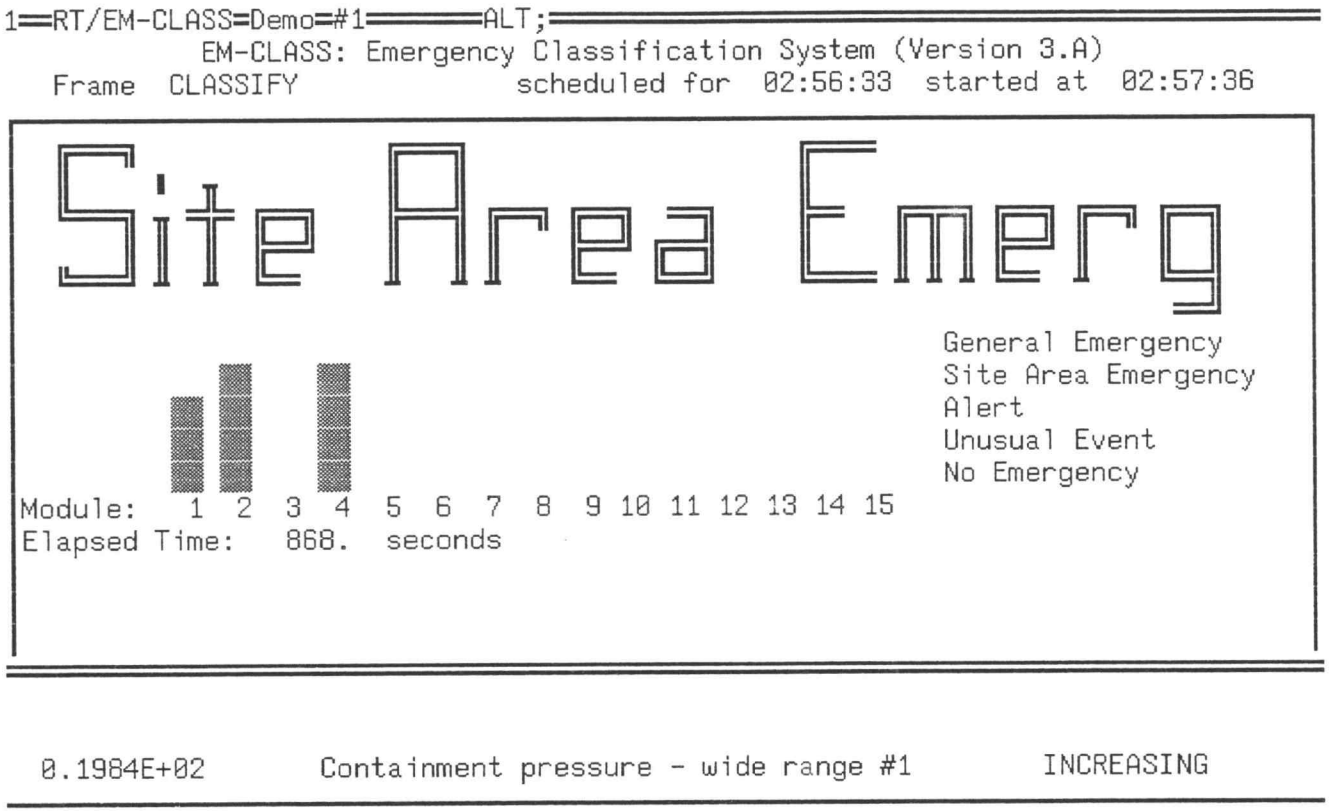


Figure 30. Scenario EAL at Time = 868 sec

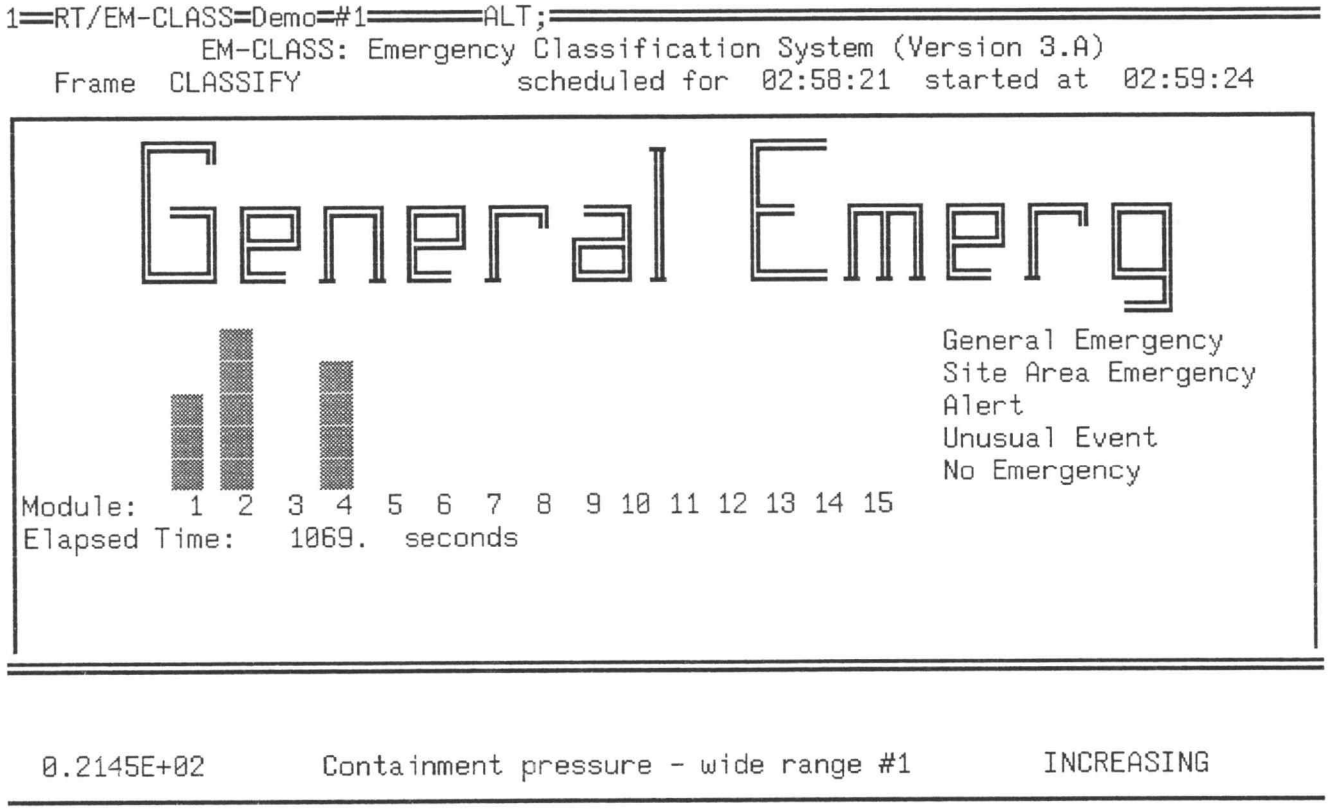


Figure 31. Scenario EAL at Time = 1069 sec

9. Integration With Plant Simulator

The key to speeding up the expert system is electronic connection to the plant data base. During development, this was accomplished by simulating the action of the plant process computer with a desk top computer such as an IBM AT. A necessary intermediate step prior to installation on the plant process computer is benchmark testing on the plant simulator.

The installation on the simulator serves several purposes. The expert system may be benchmarked and validated. It can be used during exercises, drills, and training. Through use, feedback may be provided to assure that the expert system interface with the user provides all the useful information in the required format. The installation on the simulator provides a vehicle for uncovering and removing programming errors that were undiscovered despite thorough off site testing. Finally, by using the expert system approach for emergency classification, users may gain confidence that this tool is not only useful but desirable to have in place and functioning on the Trojan nuclear power plant.

The plant simulator uses several processors connected via an ethernet computer network. The expert system may be physically attached to the simulator by installing an ethernet card in each computer. Then, a small program placed on the simulator can

query the database for relevant sensor data and periodically send this data to the expert system platform. The expert system would then be passive with respect to the simulator. This in effect minimizes or eliminates the possibility of the expert system presenting an adverse impact on the simulator.

If care is taken during shakedown and testing on the simulator, transition to the plant process control computer could be transparent with respect to the software resident on the expert system platform. Installation details would primarily involve cabling and the hardware interface.

10. Applying Technology To Other Problems

Nuclear design, such as power plant design or fuel cycle design, is a complex endeavor requiring a multitude of specialized computer programs. Many problems are iterative in nature, that is, there is no closed form solution.

An approach often attempted is to automate some portions of the design process. An example is the application of optimization theory to the Boiling Water Reactor (BWR) control rod programming task. It is perhaps no surprise that the complexity of this and other tasks makes automation difficult. Some computer programs are not well behaved outside of a narrow domain. The design engineer must verify that the solution makes sense. In the case of the control rod programming task, the resulting automated application requires significantly more time (all of it computational time) than an expert performing the classification. In addition, the automated programming task will sometimes arrive at control rod patterns that technically work but do not satisfy the operational requirements of the customer utility. This occurs because the automation removes the design engineer from the iterative loop. The design engineer interacts dynamically during the iteration, making decisions which "guide" the search for an acceptable solution. This process brings out an important point. The expert can make dynamic decisions at

intermediate steps in the solution process. The ability to guide the search through inference can be provided by expert systems.

The engineering computer codes require considerable computational resources by themselves. A real-time expert system can make a guess at a solution, submit the guess as input to the computer code, wait for the calculation to be completed, retrieve the results, analyze the results, and decide what the next step in the design process should be. The expert system would reside on a different platform from the machine that is executing the computer code.

In more advanced applications, if the design process evolved to make use of parametric search techniques, the sequential approach to computing could be expanded to make use of multiple processors, each running the engineering computer code, each controlled by the master expert system.

11. Conclusions

A real-time emergency classification expert system has been developed for use at the Trojan Nuclear Power Plant. This knowledge-based system demonstrates the techniques required to acquire plant process data from another computer and use that data in an expert system to determine the proper Emergency Action Level. This work included architecture definition, data transmission between computers, and software integration through a multi-tasking operating system, Desqview.

The RT/EM-CLASS knowledge-based system features the integration of electronically sensed plant data with the menu selection data representation of EM-CLASS. Research resolved an efficiency problem of relating plant process data to the expert system data forms through development of multi-conditional rules.

The visual display that communicates the plant status is significantly improved. It features a redundantly coded display for communicating the proper Emergency Action Level.

RT/EM-CLASS provides the following benefits:

- The resources required to make a classification are reduced, freeing the responsible person to devote

time to other important tasks.

- The classification may be completed more often and with better data than the current system allows.

- The human user is less likely to make an erroneous Emergency Action Level classification.

The ultimate goal for this project is to connect the EM-CLASS expert system directly to the plant process control computer. This task may be completed by showing the functionality of RT/EM-CLASS through use of the Trojan plant simulator.

The development of RT/EM-CLASS presents a methodology for building applications that perform non-intrusive real-time monitoring of dynamic systems. This methodology features

- Use of existing analytical and AI tools where possible
- Monitoring of dynamic systems
- Non-intrusively acquiring data from the system

This methodology has been demonstrated through an emergency classification example. It may be readily extended to solve difficult nuclear engineering design problems which require decision making in conjunction with iterative problem solving.

12. Continuation of this Work

The goal of this project is to attach the expert system platform to the plant process control computer. Appropriately, the following tasks might be considered for further effort:

- Complete installation on the simulator
- Test the implementation, refining RT/EM-CLASS as needed
- Define interface for Trojan plant process computer
- Install RT/EM-CLASS on plant process control computer
- Complete documentation and final delivery of system

The installation on the simulator is likely to be different than the installation on the plant process control computer. The difference accrues from variations in computer systems, hardware, and software. There is an additional need to observe significantly tighter constraints that are typically associated with interfacing to safety related equipment at a nuclear power plant.

Extending the expert system to take advantage of electronically available information is intended to speed up the classification process and reduce the information required of the user. The effectiveness of this approach is dependent on the

utility of plant sensor data. Perusal of the emergency classification procedure reveals that in several modules, up to 90% of the required factual knowledge is potentially available from plant instrumentation. But, the actual utilization [Figure 32] is considerably lower.

RT/EM-CLASS parameters were compared to plant data signal inputs available from the plant computers. Note that not all the RT/EM-CLASS or the emergency classification procedure parameters are defined as a function of plant sensors. For example, steps 5 and 7 of module 1 have very few questions which use plant sensor data. Some parameters are based on a field

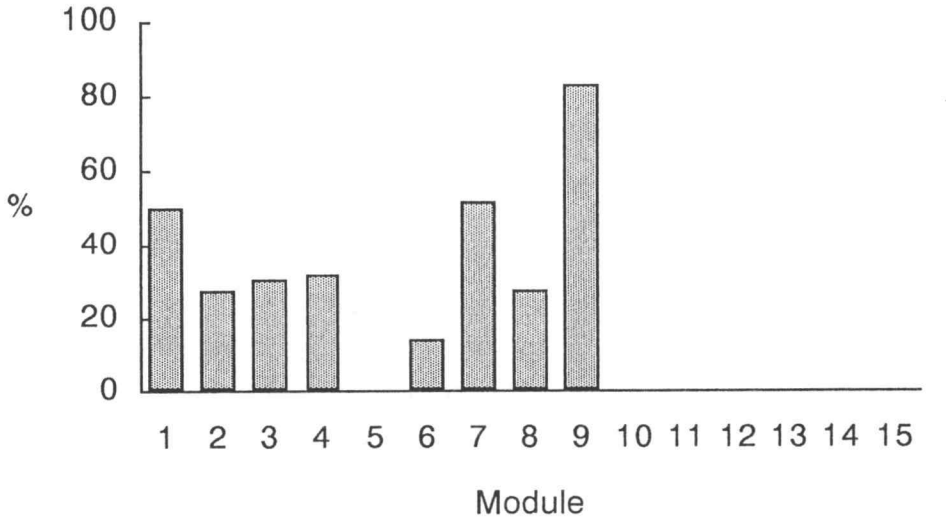


Figure 32. Facts Acquired Electronically by RT/EM-CLASS

measurement.

Sometimes, the sensor output is not available on the plant process control computer or a sensor has not been installed to perform the desired function. But in several cases, the emergency classification procedure refers to a calculational value based on one or more sensors (e.g., Integrated doses calculated at the EAB). A considerable opportunity exists to increase the utilization of electronic data. For example, consider the primary system leakage rate. The leak rate estimate is based on a system mass balance. Guessing the rate is not generally an acceptable operational method for determining the leakage rate. The control room staff uses an elaborate detailed procedure to perform this estimate. A well defined procedure can be automated. If inference is required, the capabilities of an expert system may be brought to bear. By automating the procedure, the calculation may be completed more often than once or twice per day and the results may be made available to the RT/EM-CLASS knowledge based system directly. An estimate of the potential for electronic data utilization is provided in Figure 33.

A significant effort by participants of emergency exercises requires the creation of an audit trail of documentation that substantiates all decisions and actions by the staff. This paper trail must be carried out for emergency classification as well, both directly and indirectly. The factual information which

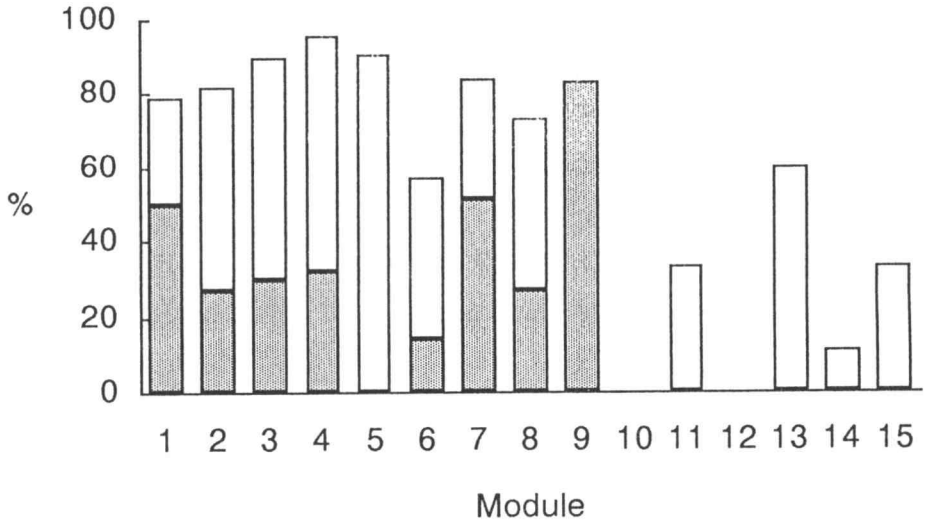


Figure 33. Potential Electronic Data Utilization

supports a conclusion is available to provide a basis for the classification. A printer could be attached to the expert system platform to print the documents associated with emergency classification. Indeed, the system could be extended to print Protective Action Recommendations (PAR's).

References

Au, M.L. (Contact Person). "Computer Monitoring of Nuclear Emergencies Proposed by NRC." Atomic Energy Clearinghouse, Volume 36 Number 41, October 12, 1990.

Bernard, J.A. and Washio, T. Expert Systems Applications Within the Nuclear Industry. American Nuclear Society, 1989.

Blanch, P. "Engineering Uses for the Off-site Facility Information Systems." EPRI Seminar Safety Parameter Display System (SPDS) Implementations and Emergency Response Facilities (ERF). EPRI, 1986.

Edwards, E. "Some Aspects of Automation in Civil Transport Aircraft." Monitoring Behavior and Supervisory Control, T.B. Sheridan and G. Johannsen, Editors. Plenum Press, 1976.

Eliot, L.B. "AI Insider: The Comeback Kid." AI Expert. October 1990, pp. 12.

Greek, K.J. Development of an Object Oriented Expert System for PWR Core Reload. Oregon State University Ph.D. Thesis. 1989.

Heaberlin, J.O. "An Expert System For Classification of Emergencies - 1988 Annual Report." Oregon State University Report OSU-NE-8903, 1989.

Heaberlin, J.O, Robinson, A.H., and Greene, K.R. "EM-CLASS: A Knowledge-Based System for Emergency Classification." Transactions of the American Nuclear Society, Volume 61, pg. 126, 1990.

Livingston, W.L. "The Impact of Three Mile Island on Process Control Computer Technology." Man-Machine Interfaces for Industrial Control (Proceedings). Control Engineering, 1980. pg. 51.

Microstuf, Cross Talk IV, 1983.

Portland General Electric Co. Trojan Emergency Procedures, EP-001, Rev. 4. 1989.

Rich, E. Artificial Intelligence. McGraw-Hill Book Company, 1983.

Salame-Alfie, A., Goldbogen, G., Ryan, R.M., Wallace, A., and Yeater, M.L. "An Expert System for Improving Emergency Response." Artificial Intelligence and Other Innovative Computer Applications in the Nuclear Industry (Majumdar, D. and Sackett, J., editors), American Nuclear Society, 1988.

Sebo, D.E., Bray, M.A., and King, M.A. "Reactor Safety Assessment System." Artificial Intelligence and Other Innovative Computer Applications in the Nuclear Industry (Majumdar, D. and Sackett, J., editors), American Nuclear Society, 1988.

Sebo, D.E., Bray, M.A., and King, M.A. "An Expert System for USNRC Emergency Response." Expert Systems in Government (Karna, K., Parsaye, K., and Silverman, B.G., editors), IEEE Computer Society Press, 1986.

Sebo, D.E., Dixon, B.W., and Bray, M.A. "A Reactor Safety Assessment System (RSAS)." International Topical Meeting on Computer Applications for Nuclear Power Plant Operation and Control, 1985 American Nuclear Society, pp. 721.

Touchton, R.A., Gunter, A.D., and Cain, D. "Reactor Emergency Action Level Monitor (REALM): An Expert System for Classifying Emergencies." Expert Systems Applications in Power Plants (EPRI Seminar Proceedings, Divakaruni, S.M., Cain, D., Baytch, E., and Saylor, C., editors) EPRI, 1987.

Touchton, R.A., Gunter, A.D., and Cain, D. "Rule-Based Emergency Action Level Monitor Prototype." Transactions of the American Nuclear Society, Volume 50, 1985.

Touchton, R.A. "Reactor Emergency Action Level Monitor." Artificial Intelligence and Other Innovative Computer Applications in the Nuclear Industry (Majumdar, D. and Sackett, J., editors), American Nuclear Society, 1988.

Touchton, R.A. "Reactor Emergency Action Level Monitor: Knowledge Acquisition Experiences." Artificial Intelligence and Other Innovative Computer Applications in the Nuclear Industry (Majumdar, D. and Sackett, J., editors), American Nuclear Society, 1988.

Touchton, R.A. Reactor Emergency Action Level Monitor: Volume 1 - Technical Report; Volume 2 - Users Guide. EPRI-NP-5719, 1988.

Texas Instruments, Inc. Online. Version 1.0, 1987.

Texas Instruments, Inc. PC Scheme - a Simple, Modern LISP.

Texas Instruments, Inc. Personal Consultant™ Plus. Version 4.0, 1988.

United States Code of Federal Regulations, Title 10, Part 50, Appendix E.

United States Nuclear Regulatory Commission. "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans." NUREG-0654.

APPENDICES

A. RT/EM-CLASS Knowledge Base

```
DOMAIN :: "RT/EM-CLASS: On-line Emergency Classification System"
ROOT FRAME :: GENERAL


======================
   Global KB data
======================

FRAME STRUCTURE ::
    GENERAL
        CLASSIFY

KB Files :: (CLASSIFY RT6.k1)
Parameter groups :: (CLASSIFY-PARMS GENERAL-PARMS)
Rule groups :: (PROMPT-CNTRL-RULES DATA-XFER-RULES EP-MODULE-01-RULES
                EP-MODULE-02-RULES EP-MODULE-03-RULES EP-MODULE-04-RULES
                EP-MODULE-05-RULES EP-MODULE-06-RULES EP-MODULE-07-RULES
                EP-MODULE-08-RULES EP-MODULE-09-RULES EP-MODULE-10-RULES
                EP-MODULE-11-RULES EP-MODULE-12-RULES EP-MODULE-13-RULES
                EP-MODULE-14-RULES EP-MODULE-15-RULES CLASSIFY-RULES
                GENERAL-RULES META-RULES )
Number of rules :: 341
Number of meta-rules :: 16
Variables :: ($$TITLE DOMAIN)
TEXTAGS :: (AL CONTINUE GEN PRE SAE UE)
Functions :: (BAR-GRAPH GET-LEVEL RETRIEVE-SHARED-DATA SELECT-ITEM
              SET-DEPTH SEVERE-CLASS SORT )


  ===============
     VARIABLES
  ===============

$$TITLE
  VALUE :: (MPRINTT :TAB 31 :ATTR (QUOTE (YELLOW)) "PROTOTYPE SYSTEM" :LINE
            :TAB 28 "FOR DEMONSTRATION ONLY" :LINE 2 :TAB 13 :ATTR (QUOTE (
            CYAN ) ) "RT/EM-CLASS: An On-line Emergency Classification
            System" :LINE :TAB 37 "for" :LINE :TAB 26 "Trojan Nuclear Power
            Plant" :LINE 2 :TAB 37 "by" :LINE 2 :TAB 34 "Ken Greene" :LINE
            :TAB 37 "and" :LINE :TAB 32 "Joan Heaberlin" :LINE 2 :TAB 27 "
            Oregon State University" :LINE :TAB 32 "September 27, 1990"
            :LINE 3 :TAB 31 :ATTR (QUOTE (YELLOW)) "PROTOTYPE SYSTEM" :LINE
            :TAB 28 "FOR DEMONSTRATION ONLY" )
DOMAIN
  VALUE :: "RT/EM-CLASS: On-line Emergency Classification System"


  =============
     TEXTAGS
  =============

AL
  TRANSLATION :: ("Events are in progress or have occurred which involve an
                   actual or potential substantial degradation of the level
                   of safety of the plant.  Limited releases of radioactive
                   material may occur, requiring onsite and offsite radiation
                   monitoring and dose projections." )
```

```
CONTINUE
  TRANSLATION :: ("This consultation will continue in order to determine if
                   a more severe emergency class applies to the current
                   situation." )
GEN
  TRANSLATION :: ("Events are in progress or have occurred which involve
                   actual or imminent substantial core degradation or melting
                   with potential or actual loss of Containment integrity."
                   )
PRE
  TRANSLATION :: ("Based on current observations, the emergency class is now"
                   )
SAE
  TRANSLATION :: ("Events are in progress or have occurred which involve
                   actual or likely major failures of Plant functions needed
                   for protection of the public.  Substantial releases of
                   radioactive material are likely or actual, but a core melt
                   situation is not indicated based on current information."
                   )
UE
  TRANSLATION :: ("Events are in progress or have occurred which indicate a
                   potential degradation of the level of safety of the plant.
                    No releases of radioactivity requiring offsite response
                   or monitoring are expected unless further problems with
                   the safety systems occur." )


  ===============
     FUNCTIONS
  ===============

BAR-GRAPH
  TRANSLATION :: (Stick the text here...)
  TEMPLATE :: (IGNORE IGNORE)
  TYPE :: ACTION
  SOURCE :: (LAMBDA
              (LIST-OF-MSGS MESSAGE)
              (LETREC
                ((PLOT-LINE
                  (' " "))
                 (LEVEL-LIST
                   (LIST "NOT CONSIDERED" "No Emergency Declared" "Unusual
                   Event" "Alert" "Site Area Emergency" "General Emergency")
                 )
                 (FORMULATE
                   (LAMBDA
                     (MSG-LIST MSG PLOT-LINE)
                     (COND
                       ((=
                         (LENGTH MSG-LIST) 0) PLOT-LINE)
                       ((NULL?
                         (MEMBER
                           (CAR MSG-LIST)
                           (MEMBER MSG LEVEL-LIST)))
                        (FORMULATE
                          (CDR MSG-LIST) MSG
                          (STRING-APPEND PLOT-LINE "    ")))
                       (T
                         (FORMULATE
                           (CDR MSG-LIST) MSG
                           (STRING-APPEND PLOT-LINE "▒▒ "))))))))
                (FORMULATE LIST-OF-MSGS MESSAGE PLOT-LINE)))
```

```
GET-LEVEL
  TRANSLATION :: (Stick the text here...)
  TEMPLATE :: (IGNORE IGNORE)
  TYPE :: ACTION
  SOURCE :: (LAMBDA
              (D-LIST N)
              (LETREC
                ((LYST
                  (CAR
                    (CDR D-LIST)))
                 (GOPHER-1
                   (LAMBDA
                     (NEW-LIST M)
                     (IF
                       (<=
                         (LENGTH NEW-LIST) M) NEW-LIST
                       (GOPHER-1
                         (CDR NEW-LIST) M)))))
                (EVAL
                  (APPEND
                    ('
                      (MIN))
                    (GOPHER-1 LYST N)))))

RETRIEVE-SHARED-DATA
  TRANSLATION :: "Stick the text here..."
  TEMPLATE :: (IGNORE IGNORE IGNORE)
  TYPE :: ACTION
  SOURCE :: (LAMBDA
              (SOURCE DESTINATION COUNT)
              (COND
                ((<= COUNT 0) NIL)
                (ELSE
                  (IF
                    (DOS-FILE-COPY SOURCE DESTINATION) #T
                    (RETRIEVE-SHARED-DATA SOURCE DESTINATION
                      (-1+ COUNT))))))

SELECT-ITEM
  TRANSLATION :: (Stick the text here...)
  TEMPLATE :: (IGNORE IGNORE IGNORE)
  TYPE :: ACTION
  SOURCE :: (LAMBDA
              (VALUE SET-POINTS ITEM-LIST)
              (COND
                ((EQ? NIL VALUE)
                 (' UNKNOWN))
                ((< VALUE
                  (CAR SET-POINTS))
                 (CAR ITEM-LIST))
                ((=
                  (LENGTH SET-POINTS) 1)
                 (CADR ITEM-LIST))
                (T
                  (SELECT-ITEM VALUE
                    (CDR SET-POINTS)
                    (CDR ITEM-LIST)))))
```

```
SET-DEPTH
  TRANSLATION :: (Stick the text here...)
  TEMPLATE :: (IGNORE IGNORE)
  TYPE :: ACTION
  SOURCE :: (LAMBDA
              (D-LIST INTERVAL)
              (IF
                (=
                  (LENGTH
                    (CADR D-LIST)) 0)
                (TRUNCATE
                  (/ INTERVAL 30))
                (LETREC
                  ((LYST
                    (CAR
                      (CDR D-LIST)))
                   (TICS
                     (-
                       (CAR
                         (REVERSE
                           (CAR
                             (CDR D-LIST)))) INTERVAL)))
                  (IF
                    (> INTERVAL
                      (CAR
                        (REVERSE LYST)))
                    (TRUNCATE
                      (/ INTERVAL 30))
                    (LETREC
                      ((MUNK-1
                        (LAMBDA
                          (NEW-LIST SET-POINT)
                          (IF
                            (< SET-POINT
                              (CADR NEW-LIST))
                            (LENGTH NEW-LIST)
                            (MUNK-1
                              (CDR NEW-LIST) SET-POINT)))))
                       (MUNK-1 LYST TICS))))))
SEVERE-CLASS
  TRANSLATION :: (the most severe emergency class from the emergency
                  classes determined above )
  TEMPLATE :: (PARMS)
  TYPE :: EXPRESSION
  SOURCE :: (LAMBDA
              (L)
              (COND
                ((MEMBER "General Emergency" L) "General Emergency")
                ((MEMBER "Site Area Emergency" L) "Site Area Emergency")
                ((MEMBER "Alert" L) "Alert")
                ((MEMBER "Unusual Event" L) "Unusual Event")
                (ELSE "No Emergency Declared")))
```

```
SORT
  TRANSLATION :: (Stick the text here...)
  TEMPLATE :: (IGNORE)
  TYPE :: ACTION
  SOURCE :: (LAMBDA
              (NUMBER-LIST)
              (LETREC
                ((UNSORTED-LIST
                  (CAR NUMBER-LIST))
                 (SORTED-LIST NIL)
                 (SORT-PROC
                   (LAMBDA
                     (NLIST SLIST)
                     (LET
                       ((ITEM
                         (EVAL
                           (APPEND
                             ('
                               (MAX)) NLIST))))
                        (COND
                          ((=
                            (LENGTH NLIST) 1)
                           (APPEND NLIST SLIST))
                          (T
                            (SORT-PROC
                              (APPEND
                                (REVERSE
                                  (CDR
                                    (MEMBER ITEM
                                      (REVERSE NLIST))))
                                (CDR
                                  (MEMBER ITEM NLIST)))
                              (APPEND
                                (LIST ITEM) SLIST))))))))
                (SORT-PROC UNSORTED-LIST SORTED-LIST)))


=======================
    Frame :: GENERAL
=======================

    IDENTIFIER :: "GENERAL-"
    INITIALDATA :: (TOPICS OPERATING-MODE TALK-INTERVAL)
    PROMPTEVER :: (This system determines the most severe emergency class to
                   be applied to the current conditon of the plant. The
                   emergency classes are established by comparing specific
                   emergency conditions to a set of limits and conditions
                   which define four emergency classes. The emergency classes
                   are used to communicate the situation severity and the
                   extent of response actions required. :line 2 The four
                   emergency classes in order of increasing severity are:
                   :line :tab 27 -- ----- -- ---------- -------- :line 2 :tab
                   30 :attr (cyan) UNUSUAL EVENT :line 2 :tab 34 :attr (
                   yellow ) ALERT :line 2 :tab 27 :attr (purple) SITE AREA
                   EMERGENCY :line 2 :tab 28 :attr (red) GENERAL EMERGENCY )
    PARMGROUP :: GENERAL-PARMS
    RULEGROUPS :: (GENERAL-RULES)
    OFFSPRING :: (CLASSIFY)
    GENERAL-PARMS  :: (OPERATING-MODE TALK-INTERVAL TOPICS)
    GENERAL-RULES  :: (RULE232)
```

```
  ====================
     GENERAL-PARMS
  ====================


OPERATING-MODE
==============
  TRANSLATION :: (operation in simulation/debugging mode)
  PROMPT :: ("Is RT/EM-CLASS being operated as a simulator for the
             purposes of development?" )
  TYPE :: YES/NO
  USED-BY :: (RULE245 RULE244)

TALK-INTERVAL
=============
  TRANSLATION :: (the number of minutes between user input)
  PROMPT :: ("How many minutes should elapse between update of parameters
             by the user?  Note that the maximum time is 30 minutes." )
  TYPE :: SINGLEVALUED
  EXPECT :: INTEGER
  USED-BY :: (RULE292 RULE291)
  RANGE :: (0 30)

TOPICS
======
  TRANSLATION :: (Problem areas to consider)
  PROMPT :: (Select the problem areas to be considered in determining the
             most severe emergency class. )
  TYPE :: ASK-ALL
  EXPECT :: ("All" "Radiological Effluent Release" "Loss of Fission
             Product Barrier" "Steam Line Break" "Main Steam Safety or
             Relief Valve Failure" "Primary or Primary-to-Secondary
             Leakage" "Pressurizer Safety or Relief Valve Failure" "Loss
             of Power or Alarms" "Loss of Feedwater" "Other Limiting
             Conditions" "Reactor Protection System Failure" "Fuel
             Handling Accident" "Control Room Evacuation" "Fire" "Security
             Threat" "Natural Phenomena" "External Hazards" "Internal
             Hazards" )
  ANTECEDENT-IN :: (RULE232)
  USED-BY-THE-WAY :: (MRULE003 MRULE001 MRULE015 MRULE014 MRULE012
                      MRULE011 MRULE010 MRULE009 MRULE008 MRULE006
                      MRULE005 MRULE004 MRULE002 MRULE007 MRULE013 )


  ====================
     GENERAL-RULES
  ====================

RULE232
=======
  SUBJECT :: GENERAL-RULES
  ANTECEDENT :: YES
  COMMENT :: "THEN :: SET-OPTIONS NO-PROMPT NO-RETURN-KEY ON AND
              FRAME-SCHEDULE CLASSIFY FROM-NOW 0"
  IF   :: (TOPICS IS KNOWN)
  THEN :: (SET-OPTIONS NO-PROMPT NO-RETURN-KEY AND FRAME-SCHEDULE
           CLASSIFY FROM-NOW 0 )
```

```
  ================
     META-RULES
  ================

MRULE001
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = "Radiological Effluent Release"
           ) )
  THEN :: (01-RELEASE = NOT CONSIDERED)

MRULE002
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = "Loss of Fission Product
           Barrier" ) AND ! (TOPICS = "Primary or Primary-to-Secondary
           Leakage" ) AND ! (TOPICS = "Pressurizer Safety or Relief Valve
           Failure" ) )
  THEN :: (02-FPBARRIER = NOT CONSIDERED)

MRULE003
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Steam Line Break) AND ! (
           TOPICS = "Main Steam Safety or Relief Valve Failure" ) )
  THEN :: (03-STEAM = NOT CONSIDERED)

MRULE004
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = "Primary or
           Primary-to-Secondary Leakage" ) AND ! (TOPICS = "Pressurizer
           Safety or Relief Valve Failure" ) AND ! (TOPICS = "Loss of
           Fission Product Barrier" ) )
  THEN :: (04-PRIMARY = NOT CONSIDERED)

MRULE005
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Loss of Power or Alarms))
  THEN :: (05-POWER = NOT CONSIDERED)

MRULE006
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Loss of Feedwater))
  THEN :: (06-FEEDWATER = NOT CONSIDERED)

MRULE007
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Other Limiting Conditions)
           AND ! (TOPICS = Loss of Fission Product Barrier) AND ! (TOPICS
           = "Loss of Feedwater" ) )
  THEN :: (07-OTHER = NOT CONSIDERED)

MRULE008
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = "Reactor Protection System
           Failure" ) )
  THEN :: (08-RPS-FAIL = NOT CONSIDERED)
```

```
MRULE009
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Fuel Handling Accident))
  THEN :: (09-FUEL = NOT CONSIDERED)

MRULE010
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Control Room Evacuation))
  THEN :: (10-CR-EVAC = NOT CONSIDERED)

MRULE011
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Fire))
  THEN :: (11-FIRE = NOT CONSIDERED)

MRULE012
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Security Threat))
  THEN :: (12-SECURITY = NOT CONSIDERED)

MRULE013
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Natural Phenomena) AND ! (
           TOPICS = "Other Limiting Conditions" ) )
  THEN :: (13-NATURAL = NOT CONSIDERED)

MRULE014
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = External Hazards))
  THEN :: (14-EXTERNAL = NOT CONSIDERED)

MRULE015
========
  SUBJECT :: META-RULES
  IF    :: (! (TOPICS = All) AND ! (TOPICS = Internal Hazards))
  THEN :: (15-INTERNAL = NOT CONSIDERED)


=======================
    Frame :: CLASSIFY
=======================

    IDENTIFIER :: "CLASSIFY-"
    PARENTS :: (GENERAL)
    GOALS :: (HEAR-FROM-USER 01-RELEASE 02-FPBARRIER 03-STEAM 04-PRIMARY
              05-POWER 06-FEEDWATER 07-OTHER 08-RPS-FAIL 09-FUEL 10-CR-EVAC
              11-FIRE 12-SECURITY 13-NATURAL 14-EXTERNAL 15-INTERNAL STATUS
              DATA-MGMT )
    PROMPT1ST :: premise
    PREMISE :: ($AND
                 (KNOWN FRAME TOPICS))
    FINAL-FUNCTIONS :: (DO-ALL (FRAME-SCHEDULE CLASSIFY FROM-START 45) (
                        DELETE-DYN-FRAME FRAME ) (E (GC #T)) )
    PARMGROUP :: CLASSIFY-PARMS
```

```
RULEGROUPS :: (CLASSIFY-RULES EP-MODULE-15-RULES EP-MODULE-14-RULES
               EP-MODULE-13-RULES EP-MODULE-12-RULES EP-MODULE-11-RULES
               EP-MODULE-10-RULES EP-MODULE-09-RULES EP-MODULE-08-RULES
               EP-MODULE-07-RULES EP-MODULE-06-RULES EP-MODULE-05-RULES
               EP-MODULE-04-RULES EP-MODULE-03-RULES EP-MODULE-02-RULES
               EP-MODULE-01-RULES DATA-XFER-RULES PROMPT-CNTRL-RULES )
META-RULES :: (MRULE001 MRULE002 MRULE003 MRULE004 MRULE005 MRULE006
               MRULE007 MRULE008 MRULE009 MRULE010 MRULE011 MRULE012
               MRULE013 MRULE014 MRULE015 )
CLASSIFY-PARMS  :: (01-RELEASE 02-FPBARRIER 03-STEAM 04-PRIMARY 05-POWER
                    06-FEEDWATER 07-OTHER 08-RPS-FAIL 09-FUEL 10-CR-EVAC
                    11-FIRE 12-SECURITY 13-NATURAL 14-EXTERNAL
                    15-INTERNAL 5-CE-TC AFW AFW-NF AFW-NO-PUMPS AFW-RT1
                    AFW-RT2 AFW-RT3 AIRBN-ACT ALARM-LOSS ARM-15 ARM-15-LK
                    ARM-20 ARM-21 ARM12/13-HI ARM22/23 ARMS-HI1 ARMS-HI2
                    ARMS-HI3 ARMS-HI4 BIV-FTC CLOCK CONT-COOL CONT-HIGH
                    CONT-HUMID CONT-LEAK-1 CONT-LEAK-2 CONT-P CORE-TC-HI5
                    CR-EVAC CR-EVAC-NO-SD CR-LIGHTS DATA-MGMT DOOR-FAIL
                    EAB-CALC EAB-DOSE EAB-I-131 EAB-LMT ECCS ECCS-FAIL
                    ED1067 ED1068 EXT-EXIST EXT-SERIOUS-DMG
                    EXT-SEVERE-DMG EXT-TOXIC1 EXT-TOXIC2 EXT-TOXIC3 F1059
                    F1060 F1061 F1062 FIRE FIRE-SAFETY1 FIRE-SAFETY2
                    FPB-COOLANT FPB-CORE FPB-FUEL FPB-FUEL-DMG FPB-LOSS-1
                    FPB-LOSS-2 FPB-LOSS-3 FUEL-DMG-LOC FUEL-HANDLING
                    FUEL-NUMBER HATCH-FAIL HEAR-FROM-USER HPI I-131
                    I-131-PC I-131-RLS I-131-RR I-LIMIT IND-NOT-SEC
                    INT-OTHER1 INT-OTHER2 INT-OTHER3 INT-TURBINE-CP
                    INT-TURBINE-SD IV-FAIL IV-FTC L1048 L1052 L1053
                    LAB-FF LEVEL LKG-COOLANT LKG-P-TS LKG-P/S-TS LKG-SGT
                    LKG-SGT-LOP LKG-SGT-SVFR LKG-UNID LKG-VER
                    LMT-ACTIVITY LMT-COLD-SD LMT-CONT-INTEG LMT-ECCS
                    LMT-ESF/FIREP LMT-HOT-SD LMT-INJURY LOCA-CHG-PMP
                    LOCA-CHR-FAIL LOCA-ECCS-FAIL M1000 M1002 M1004 M1006
                    MD1073 MD1074 MD1075 MD1076 MINUTE-15 MINUTE-2
                    MINUTE-30 MOD1-STEP1 MOD1-STEP4 MOD1-STEP6
                    MOD14-STEP1 MOD14-STEP4 MOD15-STEP1 MOD15-STEP3
                    MOD2-STEP1/2 MOD2-STEP5 MOD4-STEP1 MOD4-STEP5/6
                    MOD5-STEP1 MOD5-STEP5 MOD5-STEP7 MOD7-STEP1
                    MOD7-STEP2 MOD7-STEP3 MOD7-STEP4 MOD7-STEP5
                    MOD7-STEP6 MOD7-STEP7 MOD9-STEP1 MOD9-STEP2 MODE-4
                    MSIV-F-SG MSIV-F-SL NAT-CIRC NAT-EQUAKE NAT-FLOOD
                    NAT-TORNADO NAT-TYPE NAT-UNUSUAL NAT-VOLCANO
                    NAT-WINDS OPERATION OUTSIDE-BK P1001 P1046 P1047
                    PB-LEAK PCT-TP PRM-10 PRM-13 PRM-16 PRM-1A PRM-1B
                    PRM-1C PRM-1D PRM-1E PRM-2A PRM-2B PRM-2C PRM-2D
                    PRM-6B PRM-6C PRM-9 PRM1-HI PRM1-MODE PRM2-HI PRM3-HI
                    PRV-OPEN PWR-DG-LOSS PWR-ESF PWR-LOSS-30 PWR-LOSS-FW
                    PWR-LOSS-TS PWR-OFF/AC PWR-ON-DC PWR-ON-DC-15 PWR-UV
                    PWR-UV-1 PWR-UV-2 R1000 R1001 R1002 R1003 R1004 R1005
                    R1006 R1007 R1008 R1009 R1014 R1015 R1018 R1019 R1020
                    R1023 R1024 R1025 R1026 R1038 R1039 R1040 R1041 R1042
                    R1043 R1044 R1045 R1046 R1047 R1048 R1049 R1050 R1051
                    R1052 R1053 R1054 R1055 R1056 R1057 R1058 R1059 R1060
                    R1061 RCP-OP RCS-P RCS-P-UNC RCS-T&P RCS-T-HI
                    RCS-T-HI2 RHR RLS-EAB RLS-EXC-1HR RLS-LIMIT1-1
                    RLS-LIMIT1-2 RLS-LIMIT1-3 RLS-LIMIT2 RLS-NOT-CNTRL
                    RPS-CORE-DMG RPS-RX-CRITICAL RT RT-2MIN RT-LOW-P
                    RT-M/A RVLIS SEC-ADV-ATTACK SEC-CONTROL1 SEC-CONTROL2
                    SECURITY-ALERT SF-POOL-LOW SG-FLOW-EXC SG-LVL-DC
                    SG-TB-R SG-VLV-O1 SG-VLV-O2 SGB-RIVER SIS SIS-FLOW
                    SM-ALARM ST-FLOW-INC ST-HIGH-SIS ST-LKG ST-LKG-FD
                    ST-PD-SIS ST-SEC-DEPRES ST-VLV-RESEAT ST/P-VLV-RESEAT
                    STATUS T1119 T1121 T1123 T1125 TRANSIENT )
```

```
CLASSIFY-RULES  :: (RULE001 RULE128 RULE129 RULE212 RULE213 RULE214
                    RULE215 RULE216 RULE244 RULE245 RULE279 RULE280
                    RULE281 RULE282 RULE283 RULE285 RULE286 )
EP-MODULE-15-RULES  :: (RULE100 RULE101 RULE102 RULE103 RULE104 RULE105
                        RULE106 RULE107 )
EP-MODULE-14-RULES  :: (RULE091 RULE092 RULE093 RULE094 RULE095 RULE096
                        RULE097 RULE098 RULE099 )
EP-MODULE-13-RULES  :: (RULE087 RULE088 RULE089 RULE090 RULE114 RULE115
                        RULE116 RULE117 RULE118 RULE119 RULE120 RULE121
                        RULE122 RULE123 )
EP-MODULE-12-RULES  :: (RULE082 RULE083 RULE084 RULE085 RULE086)
EP-MODULE-11-RULES  :: (RULE078 RULE079 RULE080 RULE081)
EP-MODULE-10-RULES  :: (RULE075 RULE076 RULE077)
EP-MODULE-09-RULES  :: (RULE069 RULE070 RULE071 RULE072 RULE073 RULE074
                        RULE124 RULE125 RULE126 RULE127 RULE331 RULE332
                        RULE333 RULE334 RULE335 RULE336 RULE337 RULE338
                        RULE339 )
EP-MODULE-08-RULES  :: (RULE065 RULE066 RULE067 RULE068 RULE229 RULE230)
EP-MODULE-07-RULES  :: (RULE050 RULE051 RULE052 RULE053 RULE054 RULE055
                        RULE056 RULE057 RULE058 RULE059 RULE060 RULE061
                        RULE062 RULE063 RULE064 RULE199 RULE200 RULE201
                        RULE202 RULE203 RULE204 RULE205 RULE206 RULE207
                        RULE208 RULE209 RULE210 RULE211 RULE316 RULE317
                        RULE318 RULE319 RULE320 RULE321 RULE322 RULE323
                        RULE324 RULE325 RULE326 RULE327 RULE328 RULE329
                        RULE330 )
EP-MODULE-06-RULES  :: (RULE045 RULE046 RULE047 RULE048 RULE049 RULE198
                        RULE315 )
EP-MODULE-05-RULES  :: (RULE033 RULE034 RULE035 RULE036 RULE037 RULE038
                        RULE039 RULE040 RULE041 RULE042 RULE043 RULE044
                        RULE194 RULE195 RULE196 RULE197 RULE231 RULE287 )
EP-MODULE-04-RULES  :: (RULE021 RULE022 RULE023 RULE024 RULE025 RULE026
                        RULE027 RULE028 RULE029 RULE030 RULE031 RULE032
                        RULE187 RULE188 RULE189 RULE190 RULE191 RULE192
                        RULE193 RULE224 RULE225 RULE226 RULE227 )
EP-MODULE-03-RULES  :: (RULE017 RULE018 RULE019 RULE020 RULE178 RULE179
                        RULE180 RULE181 RULE182 RULE183 RULE184 )
EP-MODULE-02-RULES  :: (RULE012 RULE013 RULE014 RULE015 RULE016 RULE163
                        RULE164 RULE165 RULE166 RULE167 RULE168 RULE169
                        RULE170 RULE171 RULE172 RULE173 RULE174 RULE175
                        RULE176 RULE177 RULE217 RULE218 RULE219 RULE220
                        RULE221 RULE222 )
EP-MODULE-01-RULES  :: (RULE002 RULE003 RULE004 RULE005 RULE006 RULE007
                        RULE008 RULE009 RULE010 RULE011 RULE130 RULE131
                        RULE132 RULE133 RULE134 RULE135 RULE136 RULE137
                        RULE138 RULE139 RULE140 RULE141 RULE142 RULE143
                        RULE144 RULE145 RULE146 RULE147 RULE148 RULE149
                        RULE150 RULE151 RULE152 RULE153 RULE154 RULE155
                        RULE156 RULE157 RULE158 RULE159 RULE160 RULE161
                        RULE162 RULE234 RULE235 RULE236 RULE270 )
DATA-XFER-RULES  :: (RULE237 RULE238 RULE239 RULE240 RULE241 RULE242
                     RULE243 RULE246 RULE247 RULE248 RULE249 RULE250
                     RULE251 RULE252 RULE253 RULE254 RULE255 RULE256
                     RULE257 RULE258 RULE259 RULE260 RULE261 RULE262
                     RULE263 RULE264 RULE265 RULE266 RULE267 RULE268
                     RULE269 RULE271 RULE272 RULE273 RULE274 RULE275
                     RULE276 RULE277 RULE278 RULE288 RULE289 RULE290 )
PROMPT-CNTRL-RULES  :: (RULE291 RULE292 RULE293 RULE294 RULE295 RULE296
                        RULE297 RULE298 RULE299 RULE300 RULE301 RULE302
                        RULE303 RULE304 RULE305 RULE306 RULE307 RULE308
                        RULE309 RULE310 RULE311 RULE312 RULE313 RULE314
                        RULE340 RULE341 )
```

```
  ====================
     CLASSIFY-PARMS
  ====================


01-RELEASE
==========
  TRANSLATION :: (Emergency class for Module 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE011)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE001)
  CONTAINED-IN :: (RULE212)

02-FPBARRIER
============
  TRANSLATION :: (Emergency class for Module 2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE016)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE002)
  CONTAINED-IN :: (RULE212)

03-STEAM
========
  TRANSLATION :: (Emergency class for Module 3)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE017 RULE018 RULE019 RULE020)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE003)
  CONTAINED-IN :: (RULE212)

04-PRIMARY
==========
  TRANSLATION :: (Emergency class for Module 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE032)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE004)
  CONTAINED-IN :: (RULE212)

05-POWER
========
  TRANSLATION :: (Emergency class for Module 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE044)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE005)
  CONTAINED-IN :: (RULE212)

06-FEEDWATER
============
  TRANSLATION :: (Emergency class for Module 6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE045 RULE046 RULE047 RULE048 RULE049)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE006)
  CONTAINED-IN :: (RULE212)
```

```
07-OTHER
========
  TRANSLATION :: (Emergency class for Module 7)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE064)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE007)
  CONTAINED-IN :: (RULE212)

08-RPS-FAIL
===========
  TRANSLATION :: (Emergency class for Module 8)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE065 RULE066 RULE067 RULE068)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE008)
  CONTAINED-IN :: (RULE212)

09-FUEL
=======
  TRANSLATION :: (Emergency class for Module 9)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE074)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE009)
  CONTAINED-IN :: (RULE212)

10-CR-EVAC
==========
  TRANSLATION :: (Emergency class for Module 10)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE075 RULE076 RULE077)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE010)
  CONTAINED-IN :: (RULE212)

11-FIRE
=======
  TRANSLATION :: (Emergency class for Module 11)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE078 RULE079 RULE080 RULE081)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE011)
  CONTAINED-IN :: (RULE212)

12-SECURITY
===========
  TRANSLATION :: (Emergency class for Module 12)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE082 RULE083 RULE084 RULE085 RULE086)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE012)
  CONTAINED-IN :: (RULE212)
```

```
13-NATURAL
==========
  TRANSLATION :: (Emergency class for Module 13)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE088 RULE089 RULE090 RULE114 RULE115 RULE116 RULE117
                 RULE118 RULE120 RULE121 RULE122 RULE123 RULE087 RULE119
                 )
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE013)
  CONTAINED-IN :: (RULE212)
  DEFAULT :: (No Emergency Declared)

14-EXTERNAL
===========
  TRANSLATION :: (Emergency class for Module 14)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE099)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE014)
  CONTAINED-IN :: (RULE212)

15-INTERNAL
===========
  TRANSLATION :: (Emergency class for Module 15)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE107)
  USED-BY :: (RULE001)
  UPDATED-BY-THE-WAY :: (MRULE015)
  CONTAINED-IN :: (RULE212)

5-CE-TC
=======
  TRANSLATION :: (5 core thermocouples)
  PROMPT :: (Do the highest 5 core thermocouples measure --)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 620 degrees F" "> 620 degrees F" "> 714 degrees F" "
             > 1200 degrees F" )
  UPDATED-BY :: (RULE273)
  USED-BY :: (RULE170 RULE171 RULE172 RULE221 RULE193 RULE229 RULE230)

AFW
===
  TRANSLATION :: (Auxiliary feedweater flow possible)
  PROMPT :: (Is it possible to establish auxiliary feedwater flow?)
  TYPE :: YES/NO
  USED-BY :: (RULE210 RULE211)

AFW-NF
======
  TRANSLATION :: (No AFW flow/no pumps after 2 minutes)
  PROMPT :: (Do auxiliary feedwater [ AFW ] flow indicators measure zero
             flow 2 minutes after reactor trip or are AFW pumps not
             running 2 minutes after reactor trip? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE315)
  USED-BY :: (RULE198)
```

```
AFW-NO-PUMPS
============
  TRANSLATION :: (Loss of all 3 AFW pumps)
  PROMPT :: (Is there a loss of all auxiliary feedwater? :line 2 :left 3
             :attr (cyan) Answer :attr (white) YES :attr (cyan) if :attr
             (yellow ) ANY ONE :attr (cyan) of the following is true --
             :line 2 Loss of all three AFW Pumps, Modes 1, 2 and 3 :line
             :attr (yellow) OR :line :attr (cyan) AFW flow indicators
             indicate zero flow within 2 minutes after reactor trip )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE315)
  USED-BY :: (RULE045 RULE046 RULE047 RULE048 RULE049)
  COMMENT :: "Module 6, Step 1 - Entry Point"
  DEFAULT :: (NO)

AFW-RT1
=======
  TRANSLATION :: (Rx trip, all 3 AFW pumps fail)
  PROMPT :: (Is there a reactor trip followed by failure of all three
             auxiliary feedwater pumps? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE198)
  USED-BY :: (RULE046 RULE047 RULE048 RULE049)
  COMMENT :: "Module 6, Step 2"
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  DEFAULT :: (NO)

AFW-RT2
=======
  TRANSLATION :: (AFW not restored in 30 min of Rx trip)
  PROMPT :: (Is it true that auxiliary feedwater cannot be restored
             within 30 minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE047 RULE048 RULE049)
  COMMENT :: "Module 6, Step 3"

AFW-RT3
=======
  TRANSLATION :: (Loss of all charging)
  PROMPT :: (Is there a loss of all charging?)
  TYPE :: YES/NO
  USED-BY :: (RULE048 RULE049)
  COMMENT :: "Module 6, Step 4"

AIRBN-ACT
=========
  TRANSLATION :: (Iodine/Airborne part > 100 MPC)
  PROMPT :: (Is there unexpected general area iodine or particulate
             airborne concentration > 100 MPC? :line 2 :left 3 :attr (
             cyan ) MPC for iodine: :tab 8 1 E-8 microCi/cc :line MPC for
             particulate: :tab 3 3 E-7 microCi/cc )
  TYPE :: YES/NO
  USED-BY :: (RULE207)

ALARM-LOSS
==========
  TRANSLATION :: (Annunciators & comp alarms lost >5 min)
  PROMPT :: (Is there a loss of all control room annunciators and
             computer alarms for > 5 minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE042 RULE043 RULE041)
  COMMENT :: "Module 5, Step 7 - Entry Point"
```

```
ARM-15
======
  TRANSLATION :: (ARM-15A or ARM-15B dose rate)
  PROMPT :: (Enter the highest dose rate measured by :attr (yellow)
            ARM-15A :attr (white) or :attr (yellow) ARM-15B. :left 3
            :line 2 :attr (cyan) Area Radiation Monitor Locations :left
            6 :line ARM-15A Containment, Elevation 133 ft., Pressurizer
            Shed :line ARM-15B Containment, Elevation 106 ft., Laydown
            Area )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 2.0E3 mrem/hr" "> 2.0E3 mrem/hr" "> 100 R/hr, High
            alarm" )
  UPDATED-BY :: (RULE330)
  USED-BY :: (RULE176 RULE278 RULE181 RULE193 RULE204)

ARM-15-LK
=========
  TRANSLATION :: (EAB dose rate based on ARM 15A or 15B)
  PROMPT :: (Enter the calculated dose rate at the Exclusion Area
            Boundary, based on ARM-15A or ARM-15B readings, coupled with
            Containment leakage. Use adverse meteorological conditions
            [Pasquil F Stability, 1 m/sec wind velocity]. Select from --
            :left 3 :line 2 :attr (white) LIMIT A :tab 3 :attr (cyan)
            Less than 1 mR/hr :line :attr (white) LIMIT B :tab 3 :attr (
            cyan ) > 1 mR/hr :line :attr (white) LIMIT C :tab 3 :attr (
            cyan ) > 50 mrem/hr whole body for 0.5 hrs :line :tab 15 or
            5 times this level to the thyroid :line :attr (white) LIMIT
            D :tab 3 :attr (cyan) > 500 mrem/hr whole body for 2 minutes
            :line :tab 15 or 5 times this level to the thyroid )
  TYPE :: SINGLEVALUED
  EXPECT :: (LIMIT A LIMIT B LIMIT C LIMIT D)
  USED-BY :: (RULE141 RULE142)

ARM-20
======
  TRANSLATION :: (ARM-20 exposure rate)
  PROMPT :: (Enter the highest reading for ARM-20.)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 10 R/hr" "> 10 R/hr, High alarm" "> 25 R/hr
            [Refueling]" "> 200 R/hr [Power Operation]" )
  UPDATED-BY :: (RULE328 RULE327)
  USED-BY :: (RULE205)

ARM-21
======
  TRANSLATION :: (ARM-21 >15R/hr [Refuel] >200 [Operation])
  PROMPT :: (Is ARM-21 measuring > 15 R/hr during refueling or > 200 R/hr
            during power operation? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE329)
  USED-BY :: (RULE206)

ARM12/13-HI
===========
  TRANSLATION :: (High alarm on ARM-12 or ARM-13)
  PROMPT :: (Is there a high alarm for either of the following area
            radiation monitors? :left 3 :line 2 ARM-12 :tab 5 :attr (
            cyan ) High alarm at :attr (yellow) >15 mr/hr :line 2 :attr
            (white ) ARM-13 :tab 5 :attr (cyan) High alarm at :attr (
            yellow ) >15 mr/hr )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE339)
  USED-BY :: (RULE126 RULE127 RULE125)
```

```
ARM22/23
========
  TRANSLATION :: (Dose rate from ARM-22 or ARM-23)
  PROMPT :: (Enter the highest dose rate measured by :attr (yellow)
             ARM-22 :attr (white) or :attr (yellow) ARM-23. :left 3 :line
             2 :attr (cyan) Area Radiation Monitor Locations :left 6
             :line ARM-22 North Site Boundary :line ARM-23 South Site
             Boundary )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 1.0 mR/hr" ">1.0 mR/hr" ">50 mR/hr for 0.5 hr" "
             >500 mR/hr for 2 minutes" ">1000 mR/hr" )
  UPDATED-BY :: (RULE265 RULE266 RULE267 RULE268 RULE269)
  USED-BY :: (RULE161 RULE156 RULE159)

ARMS-HI1
========
  TRANSLATION :: (ARMS 1-5, 7-10, or 12-14 >2.5R/hr)
  PROMPT :: (Are any of the following ARMs measuring > 2.5 R/hr? :line 2
             :left 3 ARM 1-5 :line ARM 7-10 :line ARM 12-14 )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE321 RULE322 RULE323)
  USED-BY :: (RULE200)

ARMS-HI2
========
  TRANSLATION :: (ARMS 6, 16, or 17 >100 R/hr)
  PROMPT :: (Are any of the following ARMs measuring > 100 R/hr? :line 2
             :left 3 ARM 6 :line ARM 16 :line ARM 17 )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE324)
  USED-BY :: (RULE201)

ARMS-HI3
========
  TRANSLATION :: (ARM-11 exposure rate > 10 mR/hr)
  PROMPT :: (Is ARM-11 measuring > 10 mR/hr?)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE325)
  USED-BY :: (RULE202)

ARMS-HI4
========
  TRANSLATION :: (ARMS 18, 19, or 25 > 15 R/hr)
  PROMPT :: (Are any of the following ARMs measuring > 15 R/hr? :line 2
             :left 3 ARM 18 :line ARM 19 :line ARM 25 )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE326)
  USED-BY :: (RULE203)

BIV-FTC
=======
  TRANSLATION :: (Blowdown isolation valves fail to close)
  PROMPT :: (Have the blowdown isolation valves failed to close?)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE255)
  USED-BY :: (RULE132 RULE136)
  DEFAULT :: (NO)
  COMMENT :: "Mod 1 - Step 1.6"
```

```
CLOCK
=====
  TRANSLATION :: (time of data set collection)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE340)
  CONTAINED-IN :: (RULE212 RULE285)

CONT-COOL
=========
  TRANSLATION :: (Loss of containment cooling)
  PROMPT :: (Is there a loss of Containment cooling?)
  TYPE :: YES/NO
  USED-BY :: (RULE192)

CONT-HIGH
=========
  TRANSLATION :: (High containment pressure)
  PROMPT :: (Does there exist High Containment Pressure, High Containment
             Sump level, High Containment Humidity, or an ARM 16A or 16B
             alarm? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE278)
  USED-BY :: (RULE227)

CONT-HUMID
==========
  TRANSLATION :: (containment has high humidity)
  PROMPT :: (Is the containment humidity high?)
  TYPE :: YES/NO
  USED-BY :: (RULE278)

CONT-LEAK-1
===========
  TRANSLATION :: (containment leak >0.1% at 60 psi)
  PROMPT :: (Is containment leakage in excess of 0.1% by weight of
             containment air per dayat 60 psig [La] or 0.07% by weight at
             30 psig? )
  TYPE :: YES/NO
  USED-BY :: (RULE319)

CONT-LEAK-2
===========
  TRANSLATION :: (combined leakage >0.60 La)
  PROMPT :: (Is the combined leak rate > 0.6 La for all penetrations and
             valves subject to Type B and C tests as identified in Table
             3.6-1, when pressurized to 60 psig? )
  TYPE :: YES/NO
  USED-BY :: (RULE320)

CONT-P
======
  TRANSLATION :: (Containment pressure)
  PROMPT :: (Enter the highest Containment pressure.)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 3.5 psig" "> 3.5 psig, High alarm" "Approaching 60
             psig" )
  UPDATED-BY :: (RULE276)
  USED-BY :: (RULE176 RULE278 RULE181 RULE175 RULE192)
```

```
CORE-TC-HI5
===========
  TRANSLATION :: (fifth highest core temperature measurement)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE273)

CR-EVAC
=======
  TRANSLATION :: (Control room evacuated)
  PROMPT :: (Is the control room being evacuated?)
  TYPE :: YES/NO
  USED-BY :: (RULE075 RULE076 RULE077)
  COMMENT :: "Module 10, Step 1 - Entry Point"
  DEFAULT :: (NO)

CR-EVAC-NO-SD
=============
  TRANSLATION :: (No shutdown sys control in 15 min)
  PROMPT :: (Is the control of shutdown systems incapable of being
             established from local stations within 15 minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE076 RULE077)
  COMMENT :: "Module 10, Step 2"

CR-LIGHTS
=========
  TRANSLATION :: (Loss of Control Room normal lighting)
  PROMPT :: (Has there been a loss of control room normal lighting?)
  TYPE :: YES/NO
  USED-BY :: (RULE189)

DATA-MGMT
=========
  TRANSLATION :: (the data is saved for the next consult)
  TYPE :: YES/NO
  UPDATED-IN :: (RULE285)
  ANTECEDENT-IN :: (RULE304 RULE305 RULE306 RULE307 RULE308 RULE309
                    RULE310 RULE311 RULE312 RULE314 RULE313 )

DOOR-FAIL
=========
  TRANSLATION :: (an airlock door/seal fails)
  PROMPT :: (For either of the two airlocks, have both inner and outer
             doors or seals failed for more than 24 hours? )
  TYPE :: YES/NO
  USED-BY :: (RULE318)

EAB-CALC
========
  TRANSLATION :: (EAB dose rt >1 rem/hr wb or >5 thyroid)
  PROMPT :: (Does the dose rate calculated at the Exclusion Area Boundary
             under actual meteorological conditions exceed 1 rem/hr whole
             body or 5 rem/hr thyroid? )
  TYPE :: YES/NO
  USED-BY :: (RULE144)
```

```
EAB-DOSE
========
  TRANSLATION :: (EAB dose >1 rem wb or >5 rem thyroid)
  PROMPT :: (Is the integrated dose projected to be >1 rem whole body or
             >5 rem thyroid beyond the Exclusion Area Boundary? )
  TYPE :: SINGLEVALUED
  EXPECT :: ("No" "Yes, based on adverse meteorology" "Yes, based on
             actual meteorology" )
  USED-BY :: (RULE162 RULE270)

EAB-I-131
=========
  TRANSLATION :: (EAB I-131 concentration)
  PROMPT :: (The highest I-131 concentration [or thyroid dose rate]
             measured at the Exclusion Area Boundary is -- )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 1.0E-10 microCi/cc" ">1.0E-10 microCi/cc" ">1.0E-7
             microCi/cc [>250 mrem/hr] for 0.5 hr" ">1.0E-6 microCi/cc
             [>2500 mrem/hr] for 2 minutes" )
  USED-BY :: (RULE157 RULE160)

EAB-LMT
=======
  TRANSLATION :: (Measured EAB dose rate)
  PROMPT :: (Enter the highest dose rate measured at the Exclusion Area
             Boundary. Select from -- :left 3 :line 2 :attr (white) LIMIT
             A :tab 3 :attr (cyan) Less than 1 mR/hr :line :attr (white)
             LIMIT B :tab 3 :attr (cyan) > 1 mR/hr :line :attr (white)
             LIMIT C :tab 3 :attr (cyan) > 50 mrem/hr whole body for 0.5
             hrs :line :tab 15 or 5 times this level to the thyroid :line
             :attr (white) LIMIT D :tab 3 :attr (cyan) > 500 mrem/hr
             whole body for 2 minutes :line :tab 15 or 5 times this level
             to the thyroid :line :attr (white) LIMIT E :tab 3 :attr (
             cyan ) > 1 rem/hr whole body :line :tab 15 or 5 times this
             level to the thyroid )
  TYPE :: SINGLEVALUED
  EXPECT :: (LIMIT A LIMIT B LIMIT C LIMIT D LIMIT E)
  USED-BY :: (RULE155 RULE158 RULE143)

ECCS
====
  TRANSLATION :: (Indications of successful ECCS)
  PROMPT :: (Are there indications of successful ECCS?)
  TYPE :: YES/NO
  USED-BY :: (RULE192)

ECCS-FAIL
=========
  TRANSLATION :: (Indications of ECCS not actuated)
  PROMPT :: (Are there control room indications of ECCS not actuated, or
             no flow indications on centrifugal charging, safety
             injection and RHR pumps, after operator action? )
  TYPE :: YES/NO
  USED-BY :: (RULE193)

ED1067
======
  TRANSLATION :: (containment vent isolation TR A)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE237 RULE238 RULE239)
```

```
ED1068
======
  TRANSLATION :: (containment vent isolation TR B)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE237 RULE238 RULE239)

EXT-EXIST
=========
  TRANSLATION :: (Crash, derailment, explosion within EAB)
  PROMPT :: (Is there a crash, derailment or explosions being experienced
             in the general area? :line 2 :left 3 :attr (cyan) Answer
             :attr (white) YES :attr (cyan) if :attr (yellow) ANY ONE
             :attr (cyan) of the following is true -- :line 2 :left 6
             Aircraft, ship, etc. crash within the EAB :line :attr (
             yellow ) OR :line :attr (cyan) Aircraft circling and
             threatening the plant :line :attr (yellow) OR :line :attr (
             cyan ) Train derailment within the EAB :line :attr (yellow)
             OR :line :attr (cyan) Explosion within the EAB or warning
             from offsite :left 3 :line 2 with potential effect on plant
             operations, as determined by the Shift Supervisor. )
  TYPE :: YES/NO
  USED-BY :: (RULE091 RULE092 RULE093 RULE094)
  COMMENT :: "Module 14, Step 1 - Entry Point"

EXT-SERIOUS-DMG
===============
  TRANSLATION :: (Damage to plant structure or equipment)
  PROMPT :: (Is there serious damage to plant structure or equipment?
             :line 2 :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan ) if :attr (yellow) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Aircraft, ship, etc. crash into
             plant structures. :line :attr (yellow) OR :line :attr (cyan)
             Determination by Shift Supervisor of missile impacts on
             facility with resultant damage. :line :attr (yellow) OR
             :line :attr (cyan) Determination by Shift Supervisor of
             known explosion at facility resulting in damage to plant
             structures or equipment. )
  TYPE :: YES/NO
  USED-BY :: (RULE092 RULE093 RULE094)
  COMMENT :: "Module 14, Step 2"

EXT-SEVERE-DMG
==============
  TRANSLATION :: (Severe damage to plant!)
  PROMPT :: (Is there damage to vital plant structure or equipment? :line
             2 :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Aircraft or other vehicle crash impairing
             the safety function of vital structures (For example:
             Containment, Control Room, Auxiliary Building, Fuel
             Building, Turbine Building ) :line :attr (yellow) OR :line
             :attr (cyan) Missile or explosion impact causing loss of all
             functions needed for hot shutdown. :LINE :ATTR (yellow) OR
             :line :ATTR (cyan) Ship or other vehicle collision causing
             damage to the intake structure )
  TYPE :: YES/NO
  USED-BY :: (RULE093 RULE094)
  COMMENT :: "Module 14, Step 3"
```

```
EXT-TOXIC1
==========
  TRANSLATION :: (Toxic/flammable gases in general area)
  PROMPT :: (Is there a toxic or flammable gas release in the general
             area? :line 2 :left 3 :attr (cyan) Answer :attr (white) YES
             :attr (cyan) if :attr (yellow) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Toxic or flammable gas release
             of a magnitude that threatens personnel, as determined by
             the Shift Supervisor. :line :attr (yellow) OR :line :attr (
             cyan ) Toxic or flammable gas release warning from offsite.
             )
  TYPE :: YES/NO
  USED-BY :: (RULE095 RULE096 RULE097 RULE098)
  COMMENT :: "MODULE 14, STEP 4 - ENTRY POINT"

EXT-TOXIC2
==========
  TRANSLATION :: (Toxic/flammable gases in vital area)
  PROMPT :: (Is there an entry of toxic or flammable gases into facility
             vital areas that threatens to render safety-related
             equipment inoperable? :line 2 :left 3 :attr (cyan) Answer
             :attr (white) YES :attr (cyan) if :attr (yellow) ANY ONE
             :attr (cyan) of the following is true -- :line 2 Indications
             by observations or warning from outside the plant of toxic
             or flammable gases entering a vital area. :line :attr (
             yellow ) OR :line :attr (cyan) Detection of gases in a vital
             area in concentrations which exceed either the limits of
             flammablity or toxicity. )
  TYPE :: YES/NO
  USED-BY :: (RULE096 RULE097 RULE098)
  COMMENT :: "Module 14, Step 5"

EXT-TOXIC3
==========
  TRANSLATION :: (Toxic/flammable gases degrade safety)
  PROMPT :: (Is there an uncontrolled entry of toxic or flammable gases
             approaching toxic or explosive levels into vital areas which
             involve a significant degradation of plant safety? :line 2
             :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ALL :attr (cyan) of the following are true
             -- :line 2 Uncontrolled entry of toxic or flammable gases
             into any one of the following areas: Control Room, Cable
             Spreading Rooms, Containment, Switch Gear Room, Safe
             Shutdown Panels, Emergency Diesel Generator Rooms. :line
             :attr (yellow) AND :line :attr (cyan) Lack of access to the
             area renders a safety-related system inoperable or potential
             for fire or explosion in the area is great. :line 2 :attr (
             green ) [Press F1 for gas concentrations] )
  TYPE :: YES/NO
  USED-BY :: (RULE097 RULE098)
  HELP :: (:attr (yellow) TOXIC GASES -- :line 2 Ammonia :tab 5 100 ppm
           :line SO-2 :tab 10 5 ppm :line Chlorine :tab 5 15 ppm :line 2
           FLAMMABLE GASES -- :line 2 >50% lower flammable limits )
  COMMENT :: "Module 14, Step 6"

F1059
=====
  TRANSLATION :: (Aux FW Flow to SG A)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE315)
```

```
F1060
=====
  TRANSLATION :: (Aux FW Flow to SG B)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE315)

F1061
=====
  TRANSLATION :: (Aux FW Flow to SG C)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE315)

F1062
=====
  TRANSLATION :: (Aux FW flow to SG D)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE315)

FIRE
====
  TRANSLATION :: (Fire lasting > 10 minutes)
  PROMPT :: (Is there a fire lasting more than 10 minutes within the
             Control, Fuel, Auxiliary, Turbine, or Containment buildings?
             :line 2 :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan ) if :attr (yellow) ANY ONE :attr (cyan) of the
             following is true -- :line 2 Observation of fire lasting >
             10 minutes. :line :attr (yellow) OR :line :attr (cyan) Fire
             detection device alarm with confirming observation
             indicating fire lasting > 10 minutes. :LINE :ATTR (yellow)
             :LINE :ATTR (cyan) Fire could affect safety systems in the
             judgement of the Shift Supervisor. )
  TYPE :: YES/NO
  USED-BY :: (RULE078 RULE079 RULE080 RULE081)
  COMMENT :: "Module 11, Step 1 - Entry Point"
  DEFAULT :: (NO)

FIRE-SAFETY1
============
  TRANSLATION :: (Fire affects required safety systems)
  PROMPT :: (In the judgement of the Shift Supervisor, Is the fire
             affecting or expected to affect safety systems required for
             the present mode of operation? )
  TYPE :: YES/NO
  USED-BY :: (RULE079 RULE080 RULE081)
  COMMENT :: "Module 11, Step 2"

FIRE-SAFETY2
============
  TRANSLATION :: (Fire defeats redundant sfty sys trains)
  PROMPT :: (In the judgement of the Shift Supervisor, is the fire
             defeating redundant safety system trains or functions
             concurrent with plant conditions that may require their use
             for accident mitigation? )
  TYPE :: YES/NO
  USED-BY :: (RULE080 RULE081)
  COMMENT :: "Module 11, Step 3"
```

```
FPB-COOLANT
===========
  TRANSLATION :: (Subcool margin loss/overpressurized)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE174 RULE169 RULE173 RULE170 RULE171 RULE172)
  USED-BY :: (RULE012 RULE013 RULE014 RULE015)
  DEFAULT :: (NO)
  COMMENT :: "Module 2, Step 2 - Entry Point"

FPB-CORE
========
  TRANSLATION :: (Loss of core cooling capability)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE172 RULE221)
  USED-BY :: (RULE014 RULE015)
  DEFAULT :: (NO)
  COMMENT :: "Module 2, Step 5"

FPB-FUEL
========
  TRANSLATION :: (Fuel damage indications exist)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE165 RULE168 RULE166 RULE167)
  USED-BY :: (RULE012 RULE013 RULE014 RULE015)
  DEFAULT :: (NO)
  COMMENT :: (MODULE 2, STEP 1 - ENTRY POINT)

FPB-FUEL-DMG
============
  TRANSLATION :: (Possibility of fuel damage exists)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE165 RULE168 RULE171 RULE172)
  USED-BY :: (RULE013 RULE014 RULE015 RULE222 RULE177 RULE175)
  DEFAULT :: (NO)
  COMMENT :: "Module 2, Step 3"

FPB-LOSS-1
==========
  TRANSLATION :: (loss or imminent loss of 1 fission product barrier)
  PROMPT :: (Has there been a loss or imminent loss of one fission
             product barrier? :line 2 :left 3 :attr (cyan) Answer :attr (
             white ) YES :attr (cyan) if :attr (yellow) ANY ONE :attr (
             cyan ) of the following is true -- :left 6 :line 2 Loss or
             imminent loss of fuel cladding :line :attr (yellow) OR :line
             :attr (cyan) Loss or imminent loss of RCS pressure boundary
             resulting in leakage >50 GPM :line :attr (yellow) OR :line
             :attr (cyan) Loss or imminent loss of Containment integrity
             as defined by Standard Technical Specification Modes 1, 2,
             3, & 4 )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE222)
  USED-BY :: (RULE219 RULE218)
```

```
FPB-LOSS-2
==========
  TRANSLATION :: (loss or imminent loss of 2 fission product barriers)
  PROMPT :: (Has there been a loss of two fission product barriers or a
             loss of one with the imminent loss of the second barrier?
             :line 2 :left 3 :attr (cyan) Answer :attr (white) YES :attr
             (cyan ) if :attr (yellow) ANY TWO :attr (cyan) of the
             following is true -- :left 6 :line 2 Loss or imminent loss
             of fuel cladding :line :attr (yellow) OR :line :attr (cyan)
             Loss or imminent loss of RCS pressure boundary resulting in
             leakage >50 GPM :line :attr (yellow) OR :line :attr (cyan)
             Loss or imminent loss of Containment integrity as defined by
             Standard Technical Specification Modes 1, 2, 3, & 4 )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE218)
  USED-BY :: (RULE217 RULE219 RULE220)

FPB-LOSS-3
==========
  TRANSLATION :: (Loss of 3 fission product barriers)
  PROMPT :: (Has there been a loss of 3 fission product barriers or a
             loss of 2 fission product barriers with an imminent loss of
             the third barrier? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE176 RULE177 RULE175)
  USED-BY :: (RULE219 RULE220)
  COMMENT :: "Module 2, Step 4"
  DEFAULT :: (NO)

FUEL-DMG-LOC
============
  TRANSLATION :: (Fuel handling accident location)
  PROMPT :: (What is the location of the fuel handling accident?)
  TYPE :: SINGLEVALUED
  EXPECT :: (Containment Fuel Building)
  USED-BY :: (RULE072 RULE073 RULE126 RULE127 RULE124 RULE125)

FUEL-HANDLING
=============
  TRANSLATION :: (Spent fuel handling accident)
  PROMPT :: (Has there been a spent fuel handling accident damaging one
             or more fuel assemblies? )
  TYPE :: YES/NO
  USED-BY :: (RULE072 RULE071 RULE073 RULE126 RULE127 RULE124 RULE125)
  COMMENT :: "Module 9, Step 2 - Entry Point"

FUEL-NUMBER
===========
  TRANSLATION :: (More than one fuel assembly damaged)
  PROMPT :: (Is there major damage to more than one spent fuel assembly?)
  TYPE :: YES/NO
  USED-BY :: (RULE072 RULE073 RULE126 RULE125)

HATCH-FAIL
==========
  TRANSLATION :: (equip hatch or seal fails)
  PROMPT :: (Has the containment equipment hatch or seal failed?)
  TYPE :: YES/NO
  USED-BY :: (RULE317)
```

```
HEAR-FROM-USER
==============
  TRANSLATION :: (the user will input data)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE292 RULE291)
  ANTECEDENT-IN :: (RULE293 RULE294 RULE295 RULE297 RULE296 RULE298
                    RULE299 RULE300 RULE301 RULE303 RULE302 RULE340
                    RULE341 )

HPI
===
  TRANSLATION :: (High pressure injection possible)
  PROMPT :: (Is it possible to establish high pressure injection?)
  TYPE :: YES/NO
  USED-BY :: (RULE209)

I-131
=====
  TRANSLATION :: (Site I-131 concentration)
  PROMPT :: (The I-131 concentration determined by analysis is -- :line 2
             :attr (green) :tab 3 [Press "F1" for Technical Specification
             Limits.] )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than Tech Spec limits" "> Tech Spec limits" "> 10 times
             Tech Spec limits" )
  USED-BY :: (RULE133 RULE137)
  HELP :: (:attr (green) Technical Specification limits for I-131
           concentrations: :line 2 :attr (yellow) CONTAINMENT :line :attr
           (white ) :tab 3 1.2 E-7 microCi/cc :line 2 :attr (yellow)
           AUXILIARY BUILDING VENTS :line :attr (white) :tab 3 5.8 E-8
           microCi/cc )
  COMMENT :: "Mod 1 - Step 1.7"

I-131-PC
========
  TRANSLATION :: (I-131 primary coolant activity)
  PROMPT :: (Enter the I-131 primary coolant specific activity
             [microcuries/gram]. :line 2 :attr (green) [Press "F1" for
             help.] )
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  USED-BY :: (RULE165 RULE183 RULE166)
  HELP :: (:attr (cyan) Enter a positive integer value. :line 2 Example:
           :tab 3 :attr (yellow) 75 )

I-131-RLS
=========
  TRANSLATION :: (Releasing I-131 to environment)
  PROMPT :: (Is I-131 determined to be releasing to the environment?)
  TYPE :: YES/NO
  USED-BY :: (RULE133 RULE137)
  COMMENT :: "Mod 1 - Step 1.7"

I-131-RR
========
  TRANSLATION :: (I-131 rls >2.4E-4 Ci/sec for 0.5 hr ...)
  PROMPT :: (Does a grab sample analysis show equivalent I-131 release
             rate >2.4 E-4 Ci/sec for 0.5 hr or >2.4 E-3 Ci/sec for 2
             minutes? )
  TYPE :: YES/NO
  USED-BY :: (RULE154)
```

```
I-LIMIT
=======
  TRANSLATION :: (I-131 primary coolant activity limit)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE163 RULE164)
  USED-BY :: (RULE166)

IND-NOT-SEC
===========
  TRANSLATION :: (Indications not caused by secondary leak)
  PROMPT :: (Are the indications of)
  TYPE :: YES/NO
  USED-BY :: (RULE227)

INT-OTHER1
==========
  TRANSLATION :: (Other unusual plant conditions exist)
  PROMPT :: (Are there other plant conditions being experienced or
             projected beyond usual limits? :line 2 :left 3 :attr (cyan)
             Answer :attr (white) YES :attr (cyan) if the following is
             true -- :line 2 Other plant conditions exist that :line
             :left 6 in the judgement of the :ATTR (yellow) Shift
             Supervisor :LINE :ATTR (cyan) warrant notifying offsite
             agencies and plant management )
  TYPE :: YES/NO
  USED-BY :: (RULE103 RULE104 RULE105 RULE106)
  COMMENT :: "Module 15, Step 3 - Entry Point"

INT-OTHER2
==========
  TRANSLATION :: (Other serious plant conditions exist)
  PROMPT :: (Are there other plant conditions that can be considered
             serious? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ALL :attr (cyan) of the
             following are true -- :line 2 Other plant conditions exist
             that warrant :line 2 :left 6 Precautionary activation of the
             :LINE Technical Support Center :ATTR (yellow) AND :LINE
             :ATTR (cyan) the Operational Support Center :ATTR (yellow)
             AND :LINE :ATTR (cyan) the Emergency Operations Facility
             :attr (yellow) AND :line :attr (cyan) Placing Headquarters
             support personnel on standby at the descretion of the Plant
             General Manager. )
  TYPE :: YES/NO
  USED-BY :: (RULE104 RULE105 RULE106)
  COMMENT :: "Module 15, Step 4"

INT-OTHER3
==========
  TRANSLATION :: (Other severe plant conditions exist)
  PROMPT :: (Are there other plant conditions that can be considered
             severe? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ALL :attr (cyan) of the
             following are true -- :line 2 Other plant conditions exist
             that warrant :line 2 :left 6 Activation of the emergency
             centers and monitoring teams :line :attr (yellow) AND :line
             :attr (cyan) Precautionary public notification at the
             descretion of the Plant General Manager. )
  TYPE :: YES/NO
  USED-BY :: (RULE105 RULE106)
  COMMENT :: "Module 15, Step 5"
```

```
INT-TURBINE-CP
==============
  TRANSLATION :: (Turbine failure --> casing penetration)
  PROMPT :: (Is there a turbine failure causing casing penetration? :LINE
             2 :LEFT 3 :ATTR (cyan) Answer :ATTR (white) YES :ATTR (cyan)
             if :ATTR (yellow) ALL :ATTR (cyan) of the following are true
             -- :LINE 2 Main Turbine Trip :LINE :ATTR (yellow) AND :LINE
             :ATTR (cyan) Observation of casing penetration )
  TYPE :: YES/NO
  USED-BY :: (RULE101 RULE102)
  COMMENT :: "Module 15, Step 2"

INT-TURBINE-SD
==============
  TRANSLATION :: (Turbine rotating component --> shutdown)
  PROMPT :: (Is there a turbine rotating component causing rapid plant
             shutdown? :line 2 :left 3 :attr (cyan) Answer :attr (white)
             YES :attr (cyan) if :attr (yellow) ALL :attr (cyan) of the
             following are true -- :line 2 Turbine trip :line :attr (
             yellow ) AND :line :attr (cyan) Confirmation of rotating
             component failure )
  TYPE :: YES/NO
  USED-BY :: (RULE100 RULE101 RULE102)
  COMMENT :: "Module 15, Step 1 - Entry Point"

IV-FAIL
=======
  TRANSLATION :: (isol vlv or backup fails > 1 hr)
  PROMPT :: (Has any isolation valve (listed in Table 3.6.1) along with
             backup or blind flange failed for more than one hour? )
  TYPE :: YES/NO
  USED-BY :: (RULE316)

IV-FTC
======
  TRANSLATION :: (Isolation valves fail to close)
  PROMPT :: (Have the isolation valves failed to close?)
  TYPE :: YES/NO
  USED-BY :: (RULE131 RULE135)
  COMMENT :: "Mod 1 - Step 1.5"

L1048
=====
  TRANSLATION :: (Containment sump level - wide (A))
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE278)

L1052
=====
  TRANSLATION :: (RVLIS Full Range Tr. A)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE275)

L1053
=====
  TRANSLATION :: (RVLIS Full Range Tr B)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE275)
```

```
LAB-FF
======
  TRANSLATION :: (Failed fuel fraction)
  PROMPT :: (Has a lab analysis been performed which indicates failed
            fuel has -- )
  TYPE :: SINGLEVALUED
  EXPECT :: ("not increased" "increased 0.1% in 30 minutes" "increased 1%
            in 30 minutes" "increased to a total fraction of 5%" )
  USED-BY :: (RULE168 RULE184 RULE167)

LEVEL
=====
  TRANSLATION :: (Level of emergency classification   )
  TYPE :: SINGLEVALUED

LKG-COOLANT
===========
  TRANSLATION :: (Reactor coolant leakage rate >50 gpm)
  PROMPT :: (Is there a significant [ >50 gpm] reactor coolant leakage
            rate? )
  TYPE :: YES/NO
  USED-BY :: (RULE218 RULE027 RULE028 RULE029 RULE030 RULE031)
  COMMENT :: "Module 4, Step 7"

LKG-P-TS
========
  TRANSLATION :: (Primary Tech Spec leak rates exceeded)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE224 RULE225 RULE226)
  USED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
  DEFAULT :: (NO)
  COMMENT :: "Module 4, Step 5 - Entry Point"

LKG-P/S-TS
==========
  TRANSLATION :: (Pri-to-sec Tech Spec leak rate exceeded)
  PROMPT :: (Are primary-to-secondary Technical Specification leak rates
            exceeded? :line 2 :left 3 :attr (cyan) Answer :attr (white)
            YES :attr (cyan) if :attr (yellow) ANY ONE :attr (cyan) of
            the following is true -- :line 2 Verified
            primary-to-secondary leak rate > 1 gpm total for 4 hours,
            actual or anticipated :line :attr (yellow) OR :line :attr (
            cyan ) Verified primary-to-secondary leak rate > 500 gpd per
            steam generator for 4 hours, actual or anticipated, as
            identified by daily RCS leakage evaluation )
  TYPE :: YES/NO
  USED-BY :: (RULE021 RULE022 RULE023 RULE025 RULE024)
  COMMENT :: "Module 4, Step 1 - Entry Point"

LKG-SGT
=======
  TRANSLATION :: (Rapid gross failure of 1+ SG tubes)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE188)
  USED-BY :: (RULE022 RULE023 RULE025 RULE024 RULE189 RULE190 RULE191)
  COMMENT :: "Module 4, Step 2"
  DEFAULT :: (NO)
```

```
LKG-SGT-LOP
===========
  TRANSLATION :: (Loss of offsite power)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE189)
  USED-BY :: (RULE023 RULE025 RULE024)
  COMMENT :: "Module 4, Step 3"
  DEFAULT :: (NO)

LKG-SGT-SVFR
============
  TRANSLATION :: (SG/P PORVs/safety vlvs fail to reseat)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE190 RULE191)
  USED-BY :: (RULE023 RULE024)
  COMMENT :: "Module 4, Step 4"
  DEFAULT :: (NO)

LKG-UNID
========
  TRANSLATION :: (Unidentified primary system leak)
  PROMPT :: (Is there unidentified leakage >1 gpm for 4 hours, actual or
            anticipated? )
  TYPE :: YES/NO
  USED-BY :: (RULE225)

LKG-VER
=======
  TRANSLATION :: (Verified Primary System leakage)
  PROMPT :: (Is there a verified primary system leak rate -- :line 2
            :left 3 :attr (cyan) > 10 gpm from the Reactor Coolant
            System :line :attr (yellow) OR :line :attr (cyan) > 20 gpm
            total controlled leakage from all Reactor Coolant Pumps
            :line :attr (yellow) OR :line :attr (cyan) > 6 gpm
            controlled leakage from any one Reactor Coolant Pump at a
            Reactor Coolant System pressure of 2230 +/- 20 psig :line 2
            :attr (white) for 4 hours, actual or anticipated? )
  TYPE :: YES/NO
  USED-BY :: (RULE226)

LMT-ACTIVITY
============
  TRANSLATION :: (Hi rad levels or airborne radioactivity)
  PROMPT :: (Are there sustained high radiation levels or high airborne
            radioactivity which indicates a severe degradation in the
            control of radioactive materials in the plant? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE200 RULE201 RULE202 RULE203 RULE204 RULE205 RULE206
                RULE207 )
  USED-BY :: (RULE058 RULE059)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 7, Step 5 - Entry Point"
```

```
LMT-COLD-SD
===========
  TRANSLATION :: (System needed for cold shutdown lost)
  PROMPT :: (Is there a complete loss of any function needed for plant
             cold shutdown? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE208)
  USED-BY :: (RULE060 RULE061)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 7, Step 6 - Entry Point"

LMT-CONT-INTEG
==============
  TRANSLATION :: (Loss of containment integrity)
  PROMPT :: (Is there a loss of Containment integrity, requiring shutdown
             by Technical Specification 3.6.1.1 ? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE320 RULE319 RULE318 RULE317 RULE316)
  USED-BY :: (RULE222 RULE218 RULE050 RULE051)
  COMMENT :: "Module 7, Step 1 - Entry Point"

LMT-ECCS
========
  TRANSLATION :: (ECCS initiation & discharge to Rx)
  PROMPT :: (Is there an ECCS initiation and discharge to the reactor
             vessel? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE199)
  USED-BY :: (RULE054 RULE055)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 7, Step 3 - Entry Point"

LMT-ESF/FIREP
=============
  TRANSLATION :: (Loss of ESF requiring shutdown)
  PROMPT :: (Is there a loss of ESF requiring shutdown by Technical
             Specification 3.5 [ ECCS ] while in Mode 1 or 2 ? )
  TYPE :: YES/NO
  USED-BY :: (RULE052 RULE053)
  COMMENT :: "Module 7, Step 2 - Entry Point"

LMT-HOT-SD
==========
  TRANSLATION :: (System needed for hot shutdown lost)
  PROMPT :: (Is there a complete loss of any function needed for plant
             hot shutdown? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE209 RULE210 RULE211)
  USED-BY :: (RULE062 RULE063)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 7, Step 7 - Entry Point"

LMT-INJURY
==========
  TRANSLATION :: (Injured are overexposed or contaminated)
  PROMPT :: (Is transportation required from the site to a hospital of an
             injured individual who is overexposed and/or contaminated? )
  TYPE :: YES/NO
  USED-BY :: (RULE056 RULE057)
  COMMENT :: "Module 7, Step 4 - Entry Point"
```

```
LOCA-CHG-PMP
============
  TRANSLATION :: (LOCA > charging pump capacity)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE227)
  USED-BY :: (RULE028 RULE029 RULE030 RULE031 RULE175 RULE192 RULE193)
  DEFAULT :: (NO)
  COMMENT :: "Module 4, Step 8"

LOCA-CHR-FAIL
=============
  TRANSLATION :: (Containment heat removal system fails)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE192)
  USED-BY :: (RULE029 RULE030 RULE031)
  COMMENT :: "Module 4, Step 9"
  DEFAULT :: (NO)

LOCA-ECCS-FAIL
==============
  TRANSLATION :: (ECCS fails -> severe core degradation)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE193)
  USED-BY :: (RULE029 RULE031)
  COMMENT :: "Module 4, Step 10"
  DEFAULT :: (NO)

M1000
=====
  TRANSLATION :: (Wind speed El. 33 ft (A))
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE290 RULE289 RULE288)

M1002
=====
  TRANSLATION :: (Wind speed El. 33 ft (B))
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE290 RULE289 RULE288)

M1004
=====
  TRANSLATION :: (Wind speed El. 200 ft)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE290 RULE289 RULE288)

M1006
=====
  TRANSLATION :: (Wind speed El. 500 ft)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE290 RULE289 RULE288)
```

```
MD1073
======
  TRANSLATION :: (SG A blowdown isolation)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE255)

MD1074
======
  TRANSLATION :: (SG B blowdown isolation)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE255)

MD1075
======
  TRANSLATION :: (SG C blowdown isolation)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE255)

MD1076
======
  TRANSLATION :: (SG D blowdown isolation)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE255)

MINUTE-15
=========
  TRANSLATION :: (number of data points in last 15 minutes)
  TYPE :: SINGLEVALUED
  EXPECT :: INTEGER
  UPDATED-BY :: (RULE245 RULE244)

MINUTE-2
========
  TRANSLATION :: (number of data points in last two minutes)
  TYPE :: SINGLEVALUED
  EXPECT :: INTEGER
  UPDATED-BY :: (RULE245 RULE244)

MINUTE-30
=========
  TRANSLATION :: (number of data points in last 30 minutes)
  TYPE :: SINGLEVALUED
  EXPECT :: INTEGER
  UPDATED-BY :: (RULE245 RULE244)

MOD1-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 1, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE002 RULE003 RULE004 RULE005 RULE006)
  USED-BY :: (RULE011)
```

```
MOD1-STEP4
==========
  TRANSLATION :: (Emrgncy class for Mod 1, entry Step 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE007 RULE008 RULE009 RULE010)
  USED-BY :: (RULE011)

MOD1-STEP6
==========
  TRANSLATION :: (Emrgncy class for Mod 1 entry Step 6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE234 RULE235 RULE236)
  USED-BY :: (RULE011)

MOD14-STEP1
===========
  TRANSLATION :: (Emrgncy class for Mod 14, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE091 RULE092 RULE093 RULE094)
  USED-BY :: (RULE099)

MOD14-STEP4
===========
  TRANSLATION :: (Emrgncy class for Mod 14, entry Step 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE095 RULE096 RULE097 RULE098)
  USED-BY :: (RULE099)

MOD15-STEP1
===========
  TRANSLATION :: (Emrgncy class for Mod 15, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE100 RULE101 RULE102)
  USED-BY :: (RULE107)

MOD15-STEP3
===========
  TRANSLATION :: (Emrgncy class for Mod 15, entry Step 3)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE103 RULE104 RULE105 RULE106)
  USED-BY :: (RULE107)

MOD2-STEP1/2
============
  TRANSLATION :: (Emrgncy class for Mod 2, entry Step 1&2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE012 RULE013 RULE014 RULE015)
  USED-BY :: (RULE016)

MOD2-STEP5
==========
  TRANSLATION :: (Emrgncy class for Mod 2, entry Step 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE217 RULE219 RULE220)
  USED-BY :: (RULE016)

MOD4-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 4, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE021 RULE022 RULE023 RULE025 RULE024)
  USED-BY :: (RULE032)
```

```
MOD4-STEP5/6
============
  TRANSLATION :: (Emrgncy class for Mod 4, entry Step 5&6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
  USED-BY :: (RULE032)

MOD5-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 5, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE033 RULE034 RULE035 RULE036 RULE037)
  USED-BY :: (RULE044)

MOD5-STEP5
==========
  TRANSLATION :: (Emrgncy class for Mod 5, entry Step 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE039 RULE038 RULE040)
  USED-BY :: (RULE044)

MOD5-STEP7
==========
  TRANSLATION :: (Emrgncy class for Mod 5, entry Step 7)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE042 RULE043 RULE041)
  USED-BY :: (RULE044)

MOD7-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE050 RULE051)
  USED-BY :: (RULE064)

MOD7-STEP2
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE052 RULE053)
  USED-BY :: (RULE064)

MOD7-STEP3
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 3)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE054 RULE055)
  USED-BY :: (RULE064)

MOD7-STEP4
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 4)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE056 RULE057)
  USED-BY :: (RULE064)

MOD7-STEP5
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 5)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE058 RULE059)
  USED-BY :: (RULE064)
```

```
MOD7-STEP6
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 6)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE060 RULE061)
  USED-BY :: (RULE064)

MOD7-STEP7
==========
  TRANSLATION :: (Emrgncy class for Mod 7, entry Step 7)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE062 RULE063)
  USED-BY :: (RULE064)

MOD9-STEP1
==========
  TRANSLATION :: (Emrgncy class for Mod 9, entry Step 1)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE069 RULE070)
  USED-BY :: (RULE074)

MOD9-STEP2
==========
  TRANSLATION :: (Emrgncy class for Mod 9, entry Step 2)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE072 RULE071 RULE073 RULE126 RULE127 RULE124 RULE125)
  USED-BY :: (RULE074)

MODE-4
======
  TRANSLATION :: (Plant in hot shutdown, Mode 4)
  PROMPT :: (Is the plant in hot shutdown [Mode 4 ] ?)
  TYPE :: YES/NO
  USED-BY :: (RULE211)

MSIV-F-SG
=========
  TRANSLATION :: (MSIV from affected SG failed)
  PROMPT :: (Have the main steam isolation valves from the affected steam
             generator failed? )
  TYPE :: YES/NO
  USED-BY :: (RULE177)

MSIV-F-SL
=========
  TRANSLATION :: (MSIV in steam line fail to isolate)
  PROMPT :: (Have the main steam isolation valves in the affected steam
             line failed to isolate? )
  TYPE :: YES/NO
  USED-BY :: (RULE182)

NAT-CIRC
========
  TRANSLATION :: (Sustain natural/forced circulation)
  PROMPT :: (Is it possible to sustain natural or forced circulation?)
  TYPE :: YES/NO
  USED-BY :: (RULE208)
```

```
NAT-EQUAKE
==========
  TRANSLATION :: (Severity of earthquake)
  PROMPT :: (Enter the severity of the earthquake. Select from -- :line 2
             :attr (white) SEVERE :tab 3 :attr (cyan) Earthquake > SSE
             levels causing SSE alarms on triaxial sensors. :line 2 :attr
             (white ) SERIOUS :tab 2 :attr (cyan) Earthquake > OBE levels
             but less severe than SSE levels which cause :line :tab 9 OBE
             alarms on triaxial acceleration sensors :attr (yellow) AND
             :attr (cyan) Occurrence of :line :tab 9 earthquake confirmed
             by observation or offsite agency. :line 2 :attr (white)
             UNUSUAL :tab 2 :attr (cyan) Earthquake observed by Shift
             Supervisor or detected by plant :line :tab 9 instrumentation
             but < OBE levels. :line 2 :attr (green) :tab 9 [Press "F1"
             for definition of OBE and SSE. ] )
  TYPE :: SINGLEVALUED
  EXPECT :: (SEVERE SERIOUS UNUSUAL)
  USED-BY :: (RULE088 RULE089 RULE090)
  HELP :: (:attr (yellow) OBE :tab 3 Operating Basis Earthquake :line 2
           SSE :tab 3 Safe Shutdown Earthquake )

NAT-FLOOD
=========
  TRANSLATION :: (Severity of flood or wave surge)
  PROMPT :: (Enter the severity of the flooding or wave surge. Select
             from -- :line 2 :attr (white) SEVERE :tab 3 :attr (cyan)
             Exceeding grade level (45 feet MSL) :line 2 :attr (white)
             SERIOUS :tab 2 :attr (cyan) Within 5 feet of grade level [
             40 to 45 feet MSL ] and rising :line 2 :attr (white) UNUSUAL
             :tab 2 :attr (cyan) Greater than 27 feet MSL [ 2 feet above
             service water pump room :line :tab 9 floor] but less than 40
             feet MSL [within 5 feet of grade level] :line 2 :tab 9 MSL -
             Mean Sea Level )
  TYPE :: SINGLEVALUED
  EXPECT :: (SEVERE SERIOUS UNUSUAL)
  USED-BY :: (RULE114 RULE115 RULE116)

NAT-TORNADO
===========
  TRANSLATION :: (Tornado is striking facility)
  PROMPT :: (As determined by the Shift Supervisor, is the tornado
             striking the facility? )
  TYPE :: YES/NO
  USED-BY :: (RULE117 RULE118)
```

```
NAT-TYPE
========
  TRANSLATION :: (Type of natural phenomenon)
  PROMPT :: (What type of natural phenomenon is occurring? :attr (green)
             [Press "F1" for more information.] )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Earthquake" "Flood or Wave Surge" "Tornado" "High Winds" "
             Volcano-related Events" )
  UPDATED-BY :: (RULE290 RULE289 RULE288)
  USED-BY :: (RULE088 RULE089 RULE090 RULE114 RULE115 RULE116 RULE117
              RULE118 RULE120 RULE121 RULE122 RULE123 RULE119 )
  HELP :: (:attr (yellow) Enter -- :line :attr (white) Earthquake :attr (
           cyan ) if one observed by Shift Supervisor :line :tab 11 or
           detected on plant seismic :line :tab 11 instrumentation. :line
           :attr (white) Flood... :tab 3 :attr (cyan) if level > 27 feet
           Mean Sea Level. :line :attr (white) Tornado :tab 4 :attr (cyan
           ) if any determined to be onsite by :line :tab 11 Shift
           Supervisor. :line :attr (white) High Winds :attr (cyan) if
           sustained wind speed > 75 mph. :line :attr (white) Volcano...
           :attr (cyan) if heavy ashfall or mud flow causes :line :tab 11
           plant shutdown. )

NAT-UNUSUAL
===========
  TRANSLATION :: (Natural phenomenon being experienced)
  PROMPT :: (Is there a natural phenomenon being experienced or projected
             beyond usual limits? :attr (green) [Press "F1" for more
             information.] )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE290 RULE289 RULE288)
  USED-BY :: (RULE088 RULE089 RULE090 RULE114 RULE115 RULE116 RULE117
              RULE118 RULE120 RULE121 RULE122 RULE123 RULE087 RULE119 )
  HELP :: (:attr (cyan) Answer :attr (white) YES :attr (cyan) if an :attr
           (white ) Earthquake :attr (cyan) is observed by Shift
           Supervisor or detected on plant seismic instrumentation, or a
           :attr (white) Flood or Wave Surge :attr (cyan) level is > 27
           feet Mean Sea Level, or a :attr (white) Tornado :attr (cyan)
           is determined to be onsite by Shift Supervisor, or :attr (
           white ) High Winds :attr (cyan) occur with sustained wind
           speed > 75 mph, or :attr (white) Volcano-related events :attr
           (cyan ) such as heavy ashfall or mud flow cause plant
           shutdown. )
  COMMENT :: "Module 13, Step 1 - Entry Point"
  DEFAULT :: (NO)

NAT-VOLCANO
===========
  TRANSLATION :: (Severity of volcano-related events)
  PROMPT :: (Enter the severity of the volcano-related events, such as
             heavy ashfall or mud flow. Select from -- :line 2 :attr (
             white ) SERIOUS :tab 2 :attr (cyan) Sufficiently severe to
             adversely affect a safety system, :line :tab 9 as determined
             by the Shift Supervisor :line 2 :attr (white) UNUSUAL :tab 2
             :attr (cyan) Sufficiently severe to cause the plant to
             shutdown. )
  TYPE :: SINGLEVALUED
  EXPECT :: (SERIOUS UNUSUAL)
  USED-BY :: (RULE122 RULE123)
```

```
NAT-WINDS
=========
  TRANSLATION :: (Severity of winds)
  PROMPT :: (Enter the severity of the wind, as indicated by
             meteorological instrumention readout of wind speed in the
             control room. Select from -- :line 2 :attr (white) SEVERE
             :tab 3 :attr (cyan) Exceeding design level of 100 mph :line
             2 :attr (white) SERIOUS :tab 2 :attr (cyan) Extreme winds
             near design basis level with sustained wind :line :tab 9
             speed > 90 mph but < 100 mph :line 2 :attr (white) UNUSUAL
             :tab 2 :attr (cyan) Sustained wind speed > 75 mph but < 90
             mph :line 2 :tab 9 [mph - Miles Per Hour] )
  TYPE :: SINGLEVALUED
  EXPECT :: (SEVERE SERIOUS UNUSUAL)
  UPDATED-BY :: (RULE290 RULE289 RULE288)
  USED-BY :: (RULE120 RULE121 RULE119)

OPERATION
=========
  TRANSLATION :: (current plant operating state)
  PROMPT :: (Select the current plant operating state...)
  TYPE :: SINGLEVALUED
  EXPECT :: (Power Operations Refueling Shutdown)
  USED-BY :: (RULE328 RULE327 RULE329)

OUTSIDE-BK
==========
  TRANSLATION :: (Break outside containment, or...)
  PROMPT :: (Has there been a break outside Containment, or steam dump,
             or are steam relief or safety valves open? )
  TYPE :: YES/NO

P1001
=====
  TRANSLATION :: (RCS pressure - wide range sensor)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE272)

P1046
=====
  TRANSLATION :: (containment pressure - wide range - #1)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE238 RULE239 RULE276)

P1047
=====
  TRANSLATION :: (containment pressure - wide range - #2)
  TYPE :: SINGLEVALUED
  EXPECT :: NUMBER
  UPDATED-IN :: (RULE340)
  USED-BY :: (RULE238 RULE239)

PB-LEAK
=======
  TRANSLATION :: (Detectable pressure boundary leakage)
  PROMPT :: (Is there detectable pressure boundary leakage?)
  TYPE :: YES/NO
  USED-BY :: (RULE224)
```

```
PCT-TP
======
  TRANSLATION :: (Percent rated thermal power)
  PROMPT :: (Enter the current percent of rated thermal power. :line 2
             :attr (green) [Press "F1" for help.] )
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  USED-BY :: (RULE163 RULE164)
  HELP :: (:attr (cyan) Enter a positive integer value. :line 2 Example:
           :tab 3 :attr (yellow) 75 )
  CONTAINED-IN :: (RULE164)
  RANGE :: (0 120)

PRM-10
======
  TRANSLATION :: (PRM-10 count rate)
  PROMPT :: (The highest count rate reading for PRM-10 is --)
  TYPE :: SINGLEVALUED
  EXPECT :: (Less than 3.7E3 cpm >3.7E3 cpm, High alarm >3.7E4 cpm)
  UPDATED-BY :: (RULE254)
  USED-BY :: (RULE132 RULE136 RULE182 RULE188)
  COMMENT :: "Mod 1 - Step 1.6"

PRM-13
======
  TRANSLATION :: (PRM-13 > 3.6 E5 cpm)
  PROMPT :: (Is the reading for PRM-13 > 3.6 E5 cpm?)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE271)
  USED-BY :: (RULE184 RULE167)

PRM-16
======
  TRANSLATION :: (PRM-16 > 100 mrem/hr)
  PROMPT :: (Is the reading for PRM-16 > 100 mrem/hr [High alarm]?)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE277)
  USED-BY :: (RULE182 RULE188)

PRM-1A
======
  TRANSLATION :: (PRM-1A count rate)
  PROMPT :: (Is the reading for PRM-1A > 3.9e7 cpm [High Alarm]?)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE331)
  USED-BY :: (RULE128)

PRM-1B
======
  TRANSLATION :: (PRM-1B > 3500000. cpm)
  PROMPT :: (Is the count rate for PRM-1B greater than 3500000. cpm [High
             Alarm]? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE332)
  USED-BY :: (RULE128)
```

```
PRM-1C
======
  TRANSLATION :: (PRM-1C count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
            PRM-1C :attr (white) in :attr (yellow) PURGE MODE. :left 3
            :line 2 :attr (cyan) PRM-1C monitors Containment Effluent
            low level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ((Less than 9.9E3 cpm >9.9E3 cpm >9.9E4 cpm))
  UPDATED-BY :: (RULE240)
  USED-BY :: (RULE130 RULE134)
  COMMENT :: (MOD 1 - STEPS 1.1 2.1)

PRM-1D
======
  TRANSLATION :: (PRM-1D count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
            PRM-1D. :left 3 :line 2 :attr (cyan) PRM-1D monitors
            Containment Effluent mid level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 8.0E1 cpm" ">8.0E1 cpm, High alarm (PRESSURE
            RELIEF MODE)" ">2.0E2 cpm for 0.5 hr (PURGE MODE)" ">8.0E2
            cpm (PRESSURE RELIEF MODE)" ">2.0E3 cpm for 2 minutes (PURGE
            MODE)" ">7.0E4 cpm for 0.5 hr (PRESSURE RELIEF MODE)" ">7.0E5
            cpm for 2 minutes (PRESSURE RELIEF MODE)" )
  UPDATED-BY :: (RULE242 RULE243 RULE246 RULE248 RULE247 RULE241)
  USED-BY :: (RULE139 RULE145 RULE148 RULE138 RULE128)

PRM-1E
======
  TRANSLATION :: (PRM-1E >4.0 mR/hr for 0.5 hr or ...)
  PROMPT :: (Is :attr (yellow) PRM-1E :attr (white) reading :attr (yellow
            ) >4.0 mR/hr for 0.5 hr :attr (white) or :attr (yellow) >40
            mR/hr for 2 minutes? :left 3 :line 2 :attr (cyan) PRM-1E
            monitors Containment Effluent high level noble gas. )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE256 RULE257 RULE258)
  USED-BY :: (RULE151)

PRM-2A
======
  TRANSLATION :: (PRM-2A Aux bldg exh particulate)
  PROMPT :: (Is the reading for PRM-2A [Auxilliary Building Exhaust,
            Particulate] :LINE > 52000. cpm? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE335)
  USED-BY :: (RULE334)

PRM-2B
======
  TRANSLATION :: (PRM-2B Aux Bldg Exh, Iodine)
  PROMPT :: (Is the reading of PRM-2B [Auxilliary Building Exhaust,
            Iodine] :LINE > 4700. cpm? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE337)
  USED-BY :: (RULE336)
```

```
PRM-2C
======
  TRANSLATION :: (PRM-2C count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
            PRM-2C. :left 3 :line 2 :attr (cyan) PRM-2C monitors
            Auxiliary Building low level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ((Less than 4.7E3 cpm >4.7E3 cpm, High alarm >4.7E4 cpm))
  UPDATED-BY :: (RULE249)
  USED-BY :: (RULE146 RULE149 RULE129)

PRM-2D
======
  TRANSLATION :: (PRM-2D >8.3E1 cpm for 0.5 hr or ...)
  PROMPT :: (Enter the reading for PRM-2D... :LINE [ PRM-2D monitors
            Auxiliary Building high level noble gas.] )
  TYPE :: SINGLEVALUED
  EXPECT :: ("< 8.3E1 cpm" "> 8.3E1 cpm for 0.5 hr" "> 8.3E2 cpm, High
            alarm" "> 8.3E2 cpm for 2 minutes" )
  UPDATED-BY :: (RULE260 RULE261 RULE259)
  USED-BY :: (RULE140)

PRM-6B
======
  TRANSLATION :: (PRM-6B count rate)
  PROMPT :: (Enter the highest count rate reading for :attr (yellow)
            PRM-6B. :left 3 :line 2 :attr (cyan) PRM-6B monitors
            Condenser Air Ejector mid level noble gas. )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 1.8E2 cpm" ">1.8E2 cpm, High alarm" ">1.8E3 cpm" "
            >1.8E5 cpm for 0.5 hr" "Off-scale for 2 minutes" )
  UPDATED-BY :: (RULE250 RULE251 RULE252)
  USED-BY :: (RULE147 RULE150 RULE152 RULE182 RULE188)

PRM-6C
======
  TRANSLATION :: (PRM-6C >9.3 mR/hr for 0.5 hr or ...)
  PROMPT :: (Is :attr (yellow) PRM-6C :attr (white) reading :attr (yellow
            ) >9.3 mR/hr for 0.5 hr :attr (white) or :attr (yellow)
            >9.3E1 for 2 minutes? :left 3 :line 2 :attr (cyan) PRM-6C
            monitors Condenser Air Ejector high level noble gas. )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE263 RULE262 RULE264)
  USED-BY :: (RULE153)

PRM-9
=====
  TRANSLATION :: (PRM-9 reading)
  PROMPT :: (The highest reading for PRM-9 is --)
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than the High alarm setpoint" "> High alarm setpoint" "
            > 10 times High alarm setpoint" )
  UPDATED-BY :: (RULE253)
  USED-BY :: (RULE131 RULE135)
  COMMENT :: "Mod 1 - Step 1.5"
```

```
PRM1-HI
=======
  TRANSLATION :: (High alarm on PRM 1A, 1B, or 1D)
  PROMPT :: (Is there a high alarm for any of the following process
             radiation monitors? :left 3 :line 2 PRM-1A :tab 5 :attr (
             cyan ) High alarm at :attr (yellow) >3.9E7 cpm :line 2 :attr
             (white ) PRM-1B :tab 5 :attr (cyan) High alarm at :attr (
             yellow ) >3.5E6 cpm :line 2 :attr (white) PRM-1D :tab 5
             :attr (cyan) High alarm at :attr (yellow) >8.0E1 cpm )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE128)
  USED-BY :: (RULE181 RULE072 RULE073 RULE124)

PRM1-MODE
=========
  TRANSLATION :: (containment isolation state)
  TYPE :: SINGLEVALUED
  EXPECT :: (Isolation Mode Purge Mode Pressure Relief Mode)
  UPDATED-BY :: (RULE237 RULE238 RULE239)
  USED-BY :: (RULE242 RULE243 RULE246 RULE248 RULE247 RULE240 RULE256
              RULE257 RULE241 RULE128 RULE331 RULE332 )

PRM2-HI
=======
  TRANSLATION :: (High alarm on PRM 2A, 2B, 2C or 2D)
  PROMPT :: (Is there a high alarm for any of the following process
             radiation monitors? :left 3 :line 2 PRM-2A :tab 5 :attr (
             cyan ) High alarm at :attr (yellow) >5.2E4 cpm :line 2 :attr
             (white ) PRM-2B :tab 5 :attr (cyan) High alarm at :attr (
             yellow ) >4.7E3 cpm :line 2 :attr (white) PRM-2C :tab 5
             :attr (cyan) High alarm at :attr (yellow) >4.7E3 cpm :line 2
             :attr (white) PRM-2D :tab 5 :attr (cyan) High alarm at :attr
             (yellow ) >8.3E2 cpm )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE333 RULE123 RULE334 RULE336)
  USED-BY :: (RULE126 RULE127 RULE125)

PRM3-HI
=======
  TRANSLATION :: (High alarm on PRM 3)
  PROMPT :: (Is there a high alarm for PRM-3 :attr (yellow) [ >9.0E4 cpm]
             :attr (white) ? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE338)
  USED-BY :: (RULE126 RULE127 RULE125)

PRV-OPEN
========
  TRANSLATION :: (Pressurizer relief valves open)
  PROMPT :: (Are there symptoms to indicate that pressurizer relief
             valves are open? Symptoms include -- :left 3 :line 2 :attr (
             cyan ) PSZR RELIEF LINE HI TEMP alarm [ K10-C4 ] :line PSZR
             SAFETY RELIEF VALVE LEAKAGE HIGH alarm [ K10-D2 ] :line
             Safety valve high leakage indication :line PSZR RELIEF TANK
             HI/LO LEVEL alarm [ K13-D1 ] :line PSZR RELIEF TANK HI TEMP
             alarm [ K13-E1 ] :line PSZR RELIEF TANK HI PRESS alarm [
             K13-F1 ] :line PSZR PROTECTION LO PRESS alarm [ K13-D2 ]
             :line REACTOR TRIP PSZR LO PRESS alarm on the first out
             annunciator [ K14-D2 ] :line Fluctuation in pressurizer
             level :line Unaccountable increase in the frequency of
             primary make-up. )
  TYPE :: YES/NO
  USED-BY :: (RULE187 RULE190)
```

```
PWR-DG-LOSS
===========
  TRANSLATION :: (Loss of both diesel generators)
  PROMPT :: (What is the current status of the emergency diesel
             generators? [Actual or Anticipated] )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Both EDGs are operable" "One or both EDGs unavailable for
             short time" "One EDG unavailable for > 12 hours" "Both EDGs
             unavailable for > 2 hours" "Both EDGs unavailable for > 72
             hours" )
  USED-BY :: (RULE195 RULE231 RULE287)

PWR-ESF
=======
  TRANSLATION :: (Can energize both ESF 4.16-kV buses)
  PROMPT :: (Is it possible to energize at least one ESF 4.16-kV bus from
             diesel generators? )
  TYPE :: YES/NO
  USED-BY :: (RULE196 RULE197)

PWR-LOSS-30
===========
  TRANSLATION :: (No offsite or onsite AC power >30 min)
  PROMPT :: (Is there a loss of offsite power and loss of all onsite AC
             power >30 minutes? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE197)
  USED-BY :: (RULE035 RULE036 RULE037)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 5, Step 3"

PWR-LOSS-FW
===========
  TRANSLATION :: (No emergency feedwater makeup capability)
  PROMPT :: (Is there a loss of emergency feedwater makeup capability?
             :line 2 :attr (cyan) [Flow indicator or AFW systems shows no
             flow] )
  TYPE :: YES/NO
  USED-BY :: (RULE036 RULE037)
  COMMENT :: "Module 5, Step 4"

PWR-LOSS-TS
===========
  TRANSLATION :: (Tech Spec allowable # of power sources)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE194 RULE195 RULE231 RULE287)
  USED-BY :: (RULE033 RULE034 RULE035 RULE036 RULE037)
  DEFAULT :: (NO)
  COMMENT :: "Module 5, Step 1 - Entry Point"

PWR-OFF/AC
==========
  TRANSLATION :: (No offsite or onsite AC power)
  PROMPT :: (Is there a loss of offsite power and loss of all onsite AC
             power? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE196 RULE197)
  USED-BY :: (RULE034 RULE035 RULE036 RULE037)
  DEFAULT :: (NO)
  CERTAINTY-FACTOR-RANGE :: UNKNOWN
  COMMENT :: "Module 5, Step 2"
```

```
PWR-ON-DC
=========
  TRANSLATION :: (Loss of all vital onsite DC power)
  PROMPT :: (Is there a loss of all vital onsite DC power? :line 2 :left
             3 :attr (cyan) Answer :attr (white) YES :attr (cyan) if
             :attr (yellow) ALL :attr (cyan) of the following are true --
             :line 2 DC bus undervoltage alarms on all buses :line :attr
             (yellow ) AND :line :attr (cyan) Loss of 12.47-kV and
             4.16-kV position indicator lamps :line :attr (yellow) AND
             :line :attr (cyan) Failure to re-energize in 5 minutes )
  TYPE :: YES/NO
  USED-BY :: (RULE039 RULE038 RULE040)
  COMMENT :: (MODULE 5, STEP 5 - ENTRY POINT)

PWR-ON-DC-15
============
  TRANSLATION :: (Loss of all vital DC power for >15 min)
  PROMPT :: (Is there a loss of all vital DC power for > 15 minutes?
             [Failure to re-energize within 15 minutes] )
  TYPE :: YES/NO
  USED-BY :: (RULE039 RULE040)
  COMMENT :: "Module 5, Step 6"

PWR-UV
======
  TRANSLATION :: (Sustained undervoltage alarms 12.47-kV)
  PROMPT :: (How long has there been sustained undervoltage alarms on
             both 12.47-kV buses? )
  TYPE :: SINGLEVALUED
  EXPECT :: ("Less than 5 minutes" "> 5 minutes" "> 30 minutes" "> 12
             hours" "> 24 hours" "> 72 hours" )
  USED-BY :: (RULE194 RULE195 RULE196 RULE197 RULE287)

PWR-UV-1
========
  TRANSLATION :: (Undervoltage alrm 12.47 & 4.16 kV buses)
  PROMPT :: (Are there undervoltage alarms on the 12.47-kV and 4.16-kV
             buses? )
  TYPE :: YES/NO
  USED-BY :: (RULE189)

PWR-UV-2
========
  TRANSLATION :: (Undervoltage alrm both 12.47-kV buses)
  PROMPT :: (Are there undervoltage alarms on one or both 12.47-kV buses?
             )
  TYPE :: SINGLEVALUED
  EXPECT :: ("No undervoltage alarms" "Undervoltage alarm on one bus" "
             Undervoltage alarm on both buses" )
  USED-BY :: (RULE194 RULE195 RULE196 RULE197 RULE287)

R1000
=====
  TRANSLATION :: (PRM-1A Containment particulate)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE331)
```

```
R1001
=====
  TRANSLATION :: (PRM-1B Containment iodine)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE332)

R1002
=====
  TRANSLATION :: (PRM-1C containment vent low noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE240)

R1003
=====
  TRANSLATION :: (PRM-1D containment vent high noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE248 RULE241)

R1004
=====
  TRANSLATION :: (PRM-1E containment vent hi-hi noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE258)

R1005
=====
  TRANSLATION :: (PRM-2A Aux Bldg Exh Particulate)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE335)

R1006
=====
  TRANSLATION :: (PRM-2B Aux Bldg Exh, Iodine)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE337)

R1007
=====
  TRANSLATION :: (PRM-2C aux bldg vent low noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE249)

R1008
=====
  TRANSLATION :: (PRM-2D aux bldg vent high noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE261 RULE333)
```

```
R1009
=====
  TRANSLATION :: (PRM-3 Spent Fuel Pool Ventilation)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE338)

R1014
=====
  TRANSLATION :: (PRM-6B air ejector high noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE252)

R1015
=====
  TRANSLATION :: (PRM-6C air ejector hi-hi noble gas)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE264)

R1018
=====
  TRANSLATION :: (PRM-9 liquid rad-waste discharge)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE253)

R1019
=====
  TRANSLATION :: (PRM-10 SG blowdown)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE254)

R1020
=====
  TRANSLATION :: (Gross fuel damage PRM-13 sensor)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE271)

R1023
=====
  TRANSLATION :: (Main Steam Line A - PRM-16A)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE277)

R1024
=====
  TRANSLATION :: (Main Steam Line B - PRM-16B)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE277)
```

```
R1025
=====
  TRANSLATION :: (Main Steam Line C - PRM-16C)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE277)

R1026
=====
  TRANSLATION :: (Main Steam Line D - PRM-16D)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE277)

R1038
=====
  TRANSLATION :: (ARM-1 Aux Bldg El 5)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE321)

R1039
=====
  TRANSLATION :: (ARM-2 Aux bldg El 25)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE321)

R1040
=====
  TRANSLATION :: (ARM-3 Radiation sample room)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE321)

R1041
=====
  TRANSLATION :: (ARM-4 Aux Bldg El 45)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE321)

R1042
=====
  TRANSLATION :: (ARM-5 fuel pool area El 45)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE321)

R1043
=====
  TRANSLATION :: (ARM-6 IC Monitoring Equip)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE324)

R1044
=====
  TRANSLATION :: (ARM-7 Aux Bldg El 61)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE322)
```

```
R1045
=====
  TRANSLATION :: (ARM-8 Fuel Building El 61)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE322)

R1046
=====
  TRANSLATION :: (ARM-9 Radwaste Control)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE322)

R1047
=====
  TRANSLATION :: (ARM-10 Waste Concentrates Tank)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE322)

R1048
=====
  TRANSLATION :: (ARM-11 Control Room)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE325)

R1049
=====
  TRANSLATION :: (ARM-12 Maintenance Shop)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE323 RULE339)

R1050
=====
  TRANSLATION :: (ARM-13 New Fuel Storage)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE323 RULE339)

R1051
=====
  TRANSLATION :: (ARM-14 Radwaste Drumming Station)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE323)

R1052
=====
  TRANSLATION :: (ARM-15A Cont El 133 Press Shed)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE330)

R1053
=====
  TRANSLATION :: (ARM-15B Cont El 106 Laydown area)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE330)
```

```
R1054
=====
  TRANSLATION :: (ARM-16 RHR Room West)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE324)

R1055
=====
  TRANSLATION :: (ARM-17 RHR Room East)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE324)

R1056
=====
  TRANSLATION :: (ARM-18 VCT Room, Facade)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE326)

R1057
=====
  TRANSLATION :: (ARM-19 Letdown Line, Facade)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE326)

R1058
=====
  TRANSLATION :: (ARM-20 Manipulator Crane)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE328 RULE327)

R1059
=====
  TRANSLATION :: (ARM-21 Entry to bioshield)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE329)

R1060
=====
  TRANSLATION :: (ARM-22 north site boundary)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE265 RULE268 RULE269)

R1061
=====
  TRANSLATION :: (ARM-23 south site boundary)
  TYPE :: SINGLEVALUED
  EXPECT :: POSITIVE-NUMBER
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE265 RULE268 RULE269)
```

```
RCP-OP
======
  TRANSLATION :: (Reactor Coolant Pumps running)
  PROMPT :: (Are there any Reactor Coolant Pumps running?)
  TYPE :: YES/NO
  USED-BY :: (RULE221 RULE193)

RCS-P
=====
  TRANSLATION :: (RCS pressure)
  PROMPT :: (The current Reactor Coolant Pressure is --)
  TYPE :: SINGLEVALUED
  EXPECT :: (Less than 1807 psig Between 1807 and 2385 psig > 2385 psig)
  UPDATED-BY :: (RULE272)
  USED-BY :: (RULE169 RULE170)

RCS-P-UNC
=========
  TRANSLATION :: (RCS system pressure decreasing uncontrollably)
  PROMPT :: (Is the RCS system pressure decreasing uncontrollably?)
  TYPE :: YES/NO
  USED-BY :: (RULE227)

RCS-T&P
=======
  TRANSLATION :: (Reduces RCS temp and pressure)
  PROMPT :: (Is reactor coolant system temperature and pressure
             significantly reduced? )
  TYPE :: YES/NO
  USED-BY :: (RULE178)

RCS-T-HI
========
  TRANSLATION :: (RCS average temperature >590 F)
  PROMPT :: (Has it been verified that the Reactor Coolant System average
             temperature is > 590 degrees F? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE274)
  USED-BY :: (RULE173)

RCS-T-HI2
=========
  TRANSLATION :: (RCS temp >200 F core outlet temp)
  PROMPT :: (Has the RCS temperature increased to >200 degrees F above
             core outlet temperature? )
  TYPE :: YES/NO
  USED-BY :: (RULE208)

RHR
===
  TRANSLATION :: (RHR system operational)
  PROMPT :: (Is the Residual Heat Removal system functional or
             operational? )
  TYPE :: YES/NO
  USED-BY :: (RULE208 RULE211)
```

```
RLS-EAB
=======
  TRANSLATION :: (Dose rate >=1.0 mR/hr at the EAB)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE161 RULE156 RULE159 RULE141 RULE155 RULE157 RULE142
                 RULE158 RULE160 RULE143 )
  USED-BY :: (RULE007 RULE008 RULE009 RULE010)
  DEFAULT :: (NO)
  COMMENT :: "Module 1, Step 4 - Entry Point"

RLS-EXC-1HR
===========
  TRANSLATION :: (Effluent rls rt >Tech Spec for 1 hr)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE130 RULE134 RULE139 RULE145 RULE146 RULE147 RULE148
                 RULE150 RULE149 RULE152 RULE131 RULE133 RULE135 RULE137
                 RULE154 RULE132 RULE136 )
  USED-BY :: (RULE002 RULE003 RULE004 RULE005 RULE006)
  DEFAULT :: (NO)
  COMMENT :: "Module 1, Step 1 - Entry Point"

RLS-LIMIT1-1
============
  TRANSLATION :: (>50 mrem/hr wb for 0.5 hr at EAB,...)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE139 RULE152 RULE154 RULE151 RULE153 RULE138 RULE140)
  USED-BY :: (RULE004 RULE005 RULE006 RULE144)
  DEFAULT :: (NO)
  COMMENT :: "Module 1, Step 3"

RLS-LIMIT1-2
============
  TRANSLATION :: (Calc >50 mrem/hr wb f/.5 hrs at EAB,...)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE161 RULE159 RULE142 RULE158 RULE160 RULE143 RULE162
                 RULE270 )
  USED-BY :: (RULE008 RULE009 RULE010)
  DEFAULT :: (NO)
  COMMENT :: "Module 1, Step 5"

RLS-LIMIT1-3
============
  TRANSLATION :: (Post-Acc PRM EAB dose >50 mrem/h,...)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE152 RULE151 RULE140)
  USED-BY :: (RULE234 RULE235 RULE236)

RLS-LIMIT2
==========
  TRANSLATION :: (1 rem/hr wb or 5 rem/hr thyroid at EAB)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE161 RULE144 RULE143 RULE162)
  USED-BY :: (RULE235 RULE236 RULE005 RULE006 RULE009 RULE010)
  DEFAULT :: (NO)
  COMMENT :: (MODULE 1 STEP 7)
```

```
RLS-NOT-CNTRL
=============
  TRANSLATION :: (Rls >10 Tech Spec & not controllable)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE134 RULE139 RULE148 RULE150 RULE149 RULE152 RULE135
                 RULE137 RULE154 RULE136 )
  USED-BY :: (RULE003 RULE004 RULE005 RULE006)
  DEFAULT :: (NO)
  COMMENT :: "Module1, Step 2"

RPS-CORE-DMG
============
  TRANSLATION :: (Core cooling & makeup systems fail)
  PROMPT :: (Has a transient occurred that resulted in core damage or
             additional failure of core cooling and makeup systems? :line
             2 :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Reactor pressure is greater than safety
             valve setpoint :line :attr (yellow) OR :line :attr (cyan)
             Containment pressure is rapidly increasing :line :attr (
             yellow ) OR :line :attr (cyan) Containment temperature is
             rapidly increasing )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE229 RULE230)
  USED-BY :: (RULE067 RULE068)
  COMMENT :: "Module 8, Step 3"

RPS-RX-CRITICAL
===============
  TRANSLATION :: (RPS fails; reactor still critical)
  PROMPT :: (Is there a failure of the Reactor Protection System to
             initiate and complete a trip which brings the reactor
             subcritical by rod drop? :line 2 :left 3 :attr (cyan) Answer
             :attr (white) YES :attr (cyan) if :attr (yellow) BOTH :attr
             (cyan ) of the following are true -- :line 2 :left 6 Plant
             conditions indicate a reactor trip is required :line :attr (
             white ) OR :line :attr (cyan) Required coincidence of
             bistables have tripped :line :attr (white) OR :line :attr (
             cyan ) Trip is manually actuated :left 3 :line :attr (yellow
             ) AND :left 6 :line :attr (cyan) Sufficient control rods do
             not drop into core :line :attr (white) OR :line :attr (cyan)
             Reactor returns to criticality after trip )
  TYPE :: YES/NO
  USED-BY :: (RULE065 RULE066 RULE067 RULE068)
  COMMENT :: "Module 8, Step 1 - Entry Point"
  DEFAULT :: (NO)

RT
==
  TRANSLATION :: (Reactor trip)
  PROMPT :: (Has a reactor trip occurred or is one anticipated?)
  TYPE :: YES/NO
  USED-BY :: (RULE209 RULE210)

RT-2MIN
=======
  TRANSLATION :: (Two minutes since reactor trip)
  PROMPT :: (Have two minutes elapsed since a reactor trip?)
  TYPE :: YES/NO
  USED-BY :: (RULE315)
```

```
RT-LOW-P
========
  TRANSLATION :: (Reactor trip on low pressure or ...)
  PROMPT :: (Has there been a reactor trip on low pressure [ 1865 psig],
            or is reactor pressure decreasing uncontrollably? )
  TYPE :: YES/NO
  USED-BY :: (RULE188 RULE227)

RT-M/A
======
  TRANSLATION :: (Manual or automatic reactor trip)
  PROMPT :: (Is there a manual or automatic reactor trip?)
  TYPE :: YES/NO
  USED-BY :: (RULE198)

RVLIS
=====
  TRANSLATION :: (RLVIS full range < 39%)
  PROMPT :: (Is the Reactor Vessel Level Indicating System, RVLIS, full
            range < 39%? )
  TYPE :: YES/NO
  UPDATED-BY :: (RULE275)
  USED-BY :: (RULE221 RULE193 RULE230)

SEC-ADV-ATTACK
==============
  TRANSLATION :: (Adversary/bomb in protected area)
  PROMPT :: (Is there a physical attack on the protected area? :line 2
             :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Adversary is attacking the protected area
             barrier. :line :attr (yellow) OR :line :attr (cyan)
             Adversary is within the protected area, as determined by the
             Shift Supervisor or Security Watch Supervisor. :line :attr (
             yellow ) OR :line :attr (cyan) Bomb is found within the
             protected area. )
  TYPE :: YES/NO
  USED-BY :: (RULE083 RULE084 RULE085 RULE086)
  COMMENT :: "Module 12, Step 2"

SEC-CONTROL1
============
  TRANSLATION :: (Adversary/bomb in vital area)
  PROMPT :: (Is the physical control of the plant challenged? :line 2
             :left 3 :attr (cyan) Answer :attr (white) YES :attr (cyan)
             if :attr (yellow) ANY ONE :attr (cyan) of the following is
             true -- :line 2 Adversary is attacking the vital area
             barriers. :line :attr (yellow) OR :line :attr (cyan) Bomb is
             found within the vital area. )
  TYPE :: YES/NO
  USED-BY :: (RULE084 RULE085 RULE086)
  COMMENT :: "Module 12, Step 3"
```

```
SEC-CONTROL2
============
  TRANSLATION :: (Physical control of plant lost)
  PROMPT :: (Is the physical control of the plant lost? :line 2 :left 3
             :attr (cyan) Answer :attr (white) YES :attr (cyan) if :attr
             (yellow ) ANY ONE :attr (cyan) of the following is true --
             :line 2 Adversary has critically damaged vital equipment.
             :line :attr (yellow) OR :line :attr (cyan) Adversary has
             occupied control room or remote shutdown panel [ C-160 ]
             :line :attr (yellow) OR :line :attr (cyan) Bomb detonation
             has caused vital equipment failure. )
  TYPE :: YES/NO
  USED-BY :: (RULE085 RULE086)
  COMMENT :: "Module 12, Step 4"

SECURITY-ALERT
==============
  TRANSLATION :: (Security alert due to adversary action)
  PROMPT :: (Can a security alert be declared due to adversary action
             [per Trojan Nuclear Plant Security Plan] ? )
  TYPE :: YES/NO
  USED-BY :: (RULE082 RULE083 RULE084 RULE085 RULE086)
  COMMENT :: (MODULE 12, STEP 1 - ENTRY POINT)
  DEFAULT :: (NO)

SF-POOL-LOW
===========
  TRANSLATION :: (Spent fuel pool <10 feet above fuel)
  PROMPT :: (Is the spent fuel pool level <10 feet above the fuel?)
  TYPE :: YES/NO
  USED-BY :: (RULE069 RULE070)
  COMMENT :: "Module 9, Step 1 - Entry Point"

SG-FLOW-EXC
===========
  TRANSLATION :: (Excess flow to/from affected SG)
  PROMPT :: (Is there excess feedwater flow to and steam flow from the
             affected steam generator? )
  TYPE :: YES/NO
  USED-BY :: (RULE180)

SG-LVL-DC
=========
  TRANSLATION :: (Decreasing levels on all SGs)
  PROMPT :: (Is there decreasing wide range steam generator [ SG ] levels
             on all SGs? )
  TYPE :: YES/NO
  USED-BY :: (RULE198)

SG-TB-R
=======
  TRANSLATION :: (Symptoms of SG tube rupture)
  PROMPT :: (Do symptoms of a steam generator tube rupture exist?)
  TYPE :: YES/NO
  USED-BY :: (RULE177)

SG-VLV-O1
=========
  TRANSLATION :: (Open SG safety or relief valve)
  PROMPT :: (Is there a visual and/or audible indication of an open steam
             generator safety or relief valve? )
  TYPE :: YES/NO
  USED-BY :: (RULE179)
```

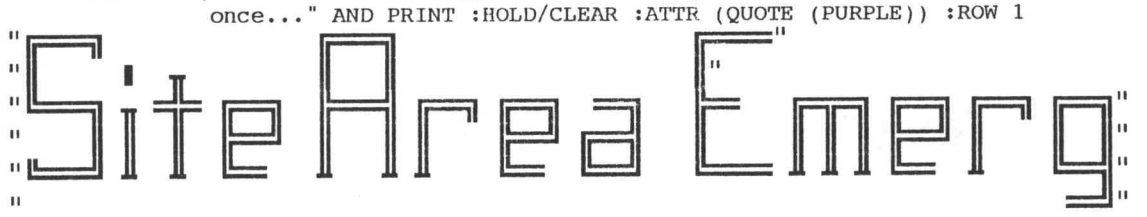
```
SG-VLV-O2
=========
  TRANSLATION :: (Open SG valve/vent stack indications)
  PROMPT :: (Is there a visual or audible indication at the vent stacks
             of an open steam generator safety or relief valve? )
  TYPE :: YES/NO
  USED-BY :: (RULE191)

SGB-RIVER
=========
  TRANSLATION :: (Steam generator blowdown to river)
  PROMPT :: (Is the steam generator blowdown directed to the river?)
  TYPE :: YES/NO
  USED-BY :: (RULE132 RULE136)
  COMMENT :: "Mod 1 - Step 1.6"

SIS
===
  TRANSLATION :: (Safety injection system operational)
  PROMPT :: (Is the Safety Injection System operational? :left 3 :line 2
             :attr (cyan) [Can SIS be verified with redundant
             instrumentation?] )
  TYPE :: YES/NO
  USED-BY :: (RULE199)

SIS-FLOW
========
  TRANSLATION :: (Charging flow or SIS flow indicated)
  PROMPT :: (Are there positive indications of charging flow [ F1-917 ]
             or SIS flow [ F1-918 or F1-922 ] ? )
  TYPE :: YES/NO
  USED-BY :: (RULE199)

SM-ALARM
========
  TRANSLATION :: (Subcooling margin alarm)
  PROMPT :: (Is there a valid subcooling margin monitor alarm [ 0 degrees
             F ] ? )
  TYPE :: YES/NO
  USED-BY :: (RULE174)

ST-FLOW-INC
===========
  TRANSLATION :: (Steam flow increase)
  PROMPT :: (Is there an increase in the steam flow?)
  TYPE :: YES/NO
  USED-BY :: (RULE178)

ST-HIGH-SIS
===========
  TRANSLATION :: (High steam flow saftey injection signal)
  PROMPT :: (Is there a High steam flow safety injection signal?)
  TYPE :: YES/NO
  USED-BY :: (RULE178 RULE181 RULE182)
```

```
ST-LKG
======
  TRANSLATION :: (Steam line breaks prim-to-sec leakage)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE181 RULE182)
  USED-BY :: (RULE018 RULE019 RULE020 RULE183 RULE184)
  DEFAULT :: (NO)
  COMMENT :: "Module 3, Step 3"

ST-LKG-FD
=========
  TRANSLATION :: (Indications of fuel damage exist)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE183 RULE184)
  USED-BY :: (RULE019 RULE020)
  DEFAULT :: (NO)
  COMMENT :: "Module 3, Step 4"

ST-PD-SIS
=========
  TRANSLATION :: (Steam line differential pressure SIS)
  PROMPT :: (Is there a steam line differential pressure safety injection
            signal? )
  TYPE :: YES/NO
  USED-BY :: (RULE178 RULE181 RULE182)

ST-SEC-DEPRES
=============
  TRANSLATION :: (Secondary system rapid depressurization)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE178)
  USED-BY :: (RULE017 RULE018 RULE019 RULE020)
  DEFAULT :: (NO)
  COMMENT :: "Module 3, Step 1 - Entry Point"

ST-VLV-RESEAT
=============
  TRANSLATION :: (SG safety/relief valves fail to reseat)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE179 RULE180)
  USED-BY :: (RULE017 RULE018 RULE019 RULE020)
  DEFAULT :: (NO)
  COMMENT :: "Module 3, Step 2 - Entry Point"

ST/P-VLV-RESEAT
===============
  TRANSLATION :: (Pszr or SG sfty/rlf vlvs fail to reseat)
  TYPE :: YES/NO
  UPDATED-BY :: (RULE187)
  USED-BY :: (RULE026 RULE027 RULE028 RULE029 RULE030 RULE031)
  COMMENT :: "Module 4 Step 6 - Entry Point"
  DEFAULT :: (NO)

STATUS
======
  TRANSLATION :: (Most severe emergency class)
  TYPE :: SINGLEVALUED
  UPDATED-BY :: (RULE001)
  ANTECEDENT-IN :: (RULE212 RULE279 RULE280 RULE281 RULE282 RULE283
                    RULE285 RULE213 RULE214 RULE215 RULE216 RULE286 )
```

```
T1119
=====
  TRANSLATION :: (RC Loop A average temperature)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE274)

T1121
=====
  TRANSLATION :: (RC Loop B average temperature)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE274)

T1123
=====
  TRANSLATION :: (RC Loop C average temperature)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE274)

T1125
=====
  TRANSLATION :: (RC Loop A average temperature)
  TYPE :: SINGLEVALUED
  UPDATED-IN :: (RULE341)
  USED-BY :: (RULE274)

TRANSIENT
=========
  TRANSLATION :: (Transient initiated or in progress)
  PROMPT :: (Is a transient occurring that requires operation of shutdown
             systems with failure to trip? :line 2 :left 3 :attr (cyan)
             Answer :attr (white) YES :attr (cyan) if :attr (yellow) ANY
             ONE :attr (cyan) of the following is true -- :line 2
             Immediate action steps in EI-0 and FR S.1 to verify reactor
             subcritical not completed :line :attr (yellow) OR :line
             :attr (cyan) Reactor is critical )
  TYPE :: YES/NO
  USED-BY :: (RULE042 RULE043 RULE066 RULE067 RULE068)
  COMMENT :: "Module 5, Step 8 and Module 8, Step 2"


  ====================
     CLASSIFY-RULES
  ====================

RULE001
=======
  SUBJECT :: CLASSIFY-RULES
  IF    :: (FINDOUT 01-RELEASE AND FINDOUT 02-FPBARRIER AND FINDOUT
            03-STEAM AND FINDOUT 04-PRIMARY AND FINDOUT 05-POWER AND
            FINDOUT 06-FEEDWATER AND FINDOUT 07-OTHER AND FINDOUT
            08-RPS-FAIL AND FINDOUT 09-FUEL AND FINDOUT 10-CR-EVAC AND
            FINDOUT 11-FIRE AND FINDOUT 12-SECURITY AND FINDOUT 13-NATURAL
            AND FINDOUT 14-EXTERNAL AND FINDOUT 15-INTERNAL )
  THEN :: (STATUS = (E (SEVERE-CLASS (LIST (VAL1 FRAME 01-RELEASE) (VAL1
            FRAME 02-FPBARRIER ) (VAL1 FRAME 03-STEAM) (VAL1 FRAME
            04-PRIMARY ) (VAL1 FRAME 05-POWER) (VAL1 FRAME 06-FEEDWATER) (
            VAL1 FRAME 07-OTHER ) (VAL1 FRAME 08-RPS-FAIL) (VAL1 FRAME
            09-FUEL ) (VAL1 FRAME 10-CR-EVAC) (VAL1 FRAME 11-FIRE) (VAL1
            FRAME 12-SECURITY ) (VAL1 FRAME 13-NATURAL) (VAL1 FRAME
            14-EXTERNAL ) (VAL1 FRAME 15-INTERNAL) ) ) ) )
```

```
RULE128
=======
  SUBJECT :: CLASSIFY-RULES
  IF    :: ((PRM-1D != "Less than 8.0E1 cpm" AND PRM1-MODE = "Pressure
            Relief Mode" ) OR PRM-1B OR PRM-1A )
  THEN :: (PRM1-HI)

RULE129
=======
  SUBJECT :: CLASSIFY-RULES
  IF    :: (PRM-2C = >4.7E3 cpm, High alarm OR PRM-2C = >4.7E4 cpm)
  THEN :: (PRM2-HI)

RULE212
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  UTILITY :: -100
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :LEFT 9 :TAB 22 "S U M M A R Y" :LINE 2 "Elapsed Time:"
            :TAB 25 CLOCK :LINE :ATTR (QUOTE (WHITE)) "Module
            1-Radiological Release:" :TAB 7 01-RELEASE :LINE "Module
            2-Fission Product Barrier:" :TAB 4 02-FPBARRIER :LINE "Module
            3-Steam Line Break:" :TAB 11 03-STEAM :LINE "Module
            4-Primary/Secondary System:" :TAB 3 04-PRIMARY :LINE "Module
            5-Loss of Power or Alarms:" :TAB 4 05-POWER :LINE "Module
            6-Loss of Feedwater:" :TAB 10 06-FEEDWATER :LINE "Module
            7-Other Limiting Conditions:" :TAB 2 07-OTHER AND PRINT :LEFT
            9 :ATTR (QUOTE (WHITE)) "Module  8-Reactor Protection System:"
            :TAB 2 08-RPS-FAIL :LINE "Module  9-Fuel Handling/Storage:"
            :TAB 6 09-FUEL :LINE "Module 10-Control Room Evacuation:" :TAB
            4 10-CR-EVAC :LINE "Module 11-Fire:" :TAB 23 11-FIRE :LINE "
            Module 12-Security Threat:" :TAB 12 12-SECURITY :LINE "Module
            13-Natural Phenomena:" :TAB 10 13-NATURAL :LINE "Module
            14-External Hazards:" :TAB 11 14-EXTERNAL :LINE "Module
            15-Internal Hazards:" :TAB 11 15-INTERNAL :LINE )

RULE213
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = Alert)
  THEN :: (PRINT :LINE :ATTR (QUOTE (blink red)) "Press [ALT] then [F8]
            once..." AND PRINT :HOLD/CLEAR :ATTR (QUOTE (YELLOW)) :ROW 1
            :TAB 28 "
     :LINE :TAB 28 "
     :LINE :TAB 28 "
     :LINE :TAB 28 "
     :LINE :TAB 28 "
     :LINE )
```

```
RULE214
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = Site Area Emergency)
  THEN :: (PRINT :LINE :ATTR (QUOTE (blink red)) "Press [ALT] then [F8]
           once..." AND PRINT :HOLD/CLEAR :ATTR (QUOTE (PURPLE)) :ROW 1
```

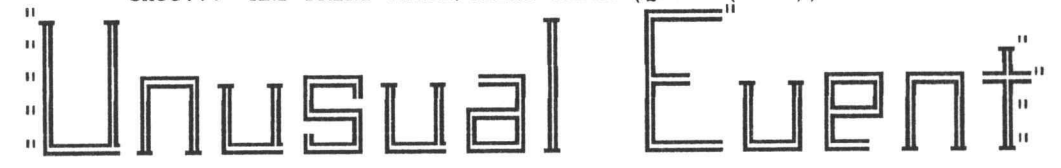



```
 )
```

```
RULE215
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = General Emergency)
  THEN :: (PRINT :LINE :ATTR (QUOTE (blink red)) "Print [ALT] then [F8]
           once..." AND PRINT :HOLD/CLEAR :ATTR (QUOTE (RED)) :ROW 1
```


```
   )
```

```
RULE216
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = Unusual Event)
  THEN :: (PRINT :LINE :ATTR (QUOTE (blink red)) "Press [ALT] then [F8]
           once..." AND PRINT :HOLD/CLEAR :ATTR (QUOTE (CYAN)) :ROW 1
```




```
  :LINE )

RULE244
=======
  SUBJECT :: CLASSIFY-RULES
  IF    :: (OPERATING-MODE)
  THEN :: (MINUTE-30 = 1 AND MINUTE-15 = 1 AND MINUTE-2 = 1)

RULE245
=======
  SUBJECT :: CLASSIFY-RULES
  IF    :: (! OPERATING-MODE)
  THEN :: (MINUTE-2 = (E (SET-DEPTH (GET-TREND CLOCK ALL) 120)) AND
           MINUTE-15 = (E (SET-DEPTH (GET-TREND CLOCK ALL) 900)) AND
           MINUTE-30 = (E (SET-DEPTH (GET-TREND CLOCK ALL) 1800)) )
```

```
RULE279
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  DOBEFORE :: (RULE213 RULE214 RULE215 RULE216 RULE286)
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :ATTR (QUOTE (RED)) :TAB 8 (E (BAR-GRAPH (LIST (VAL1
          FRAME 01-RELEASE ) (VAL1 FRAME 02-FPBARRIER) (VAL1 FRAME
          03-STEAM ) (VAL1 FRAME 04-PRIMARY) (VAL1 FRAME 05-POWER) (VAL1
          FRAME 06-FEEDWATER ) (VAL1 FRAME 07-OTHER) (VAL1 FRAME
          08-RPS-FAIL ) (VAL1 FRAME 09-FUEL) (VAL1 FRAME 10-CR-EVAC) (
          VAL1 FRAME 11-FIRE ) (VAL1 FRAME 12-SECURITY) (VAL1 FRAME
          13-NATURAL ) (VAL1 FRAME 14-EXTERNAL) (VAL1 FRAME 15-INTERNAL)
          ) "General Emergency" ) ) :TAB 2 "General Emergency" )

RULE280
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  DOBEFORE :: (RULE279 RULE286 RULE213 RULE214 RULE215 RULE216)
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :ATTR (QUOTE (PURPLE)) :TAB 8 (E (BAR-GRAPH (LIST (VAL1
          FRAME 01-RELEASE ) (VAL1 FRAME 02-FPBARRIER) (VAL1 FRAME
          03-STEAM ) (VAL1 FRAME 04-PRIMARY) (VAL1 FRAME 05-POWER) (VAL1
          FRAME 06-FEEDWATER ) (VAL1 FRAME 07-OTHER) (VAL1 FRAME
          08-RPS-FAIL ) (VAL1 FRAME 09-FUEL) (VAL1 FRAME 10-CR-EVAC) (
          VAL1 FRAME 11-FIRE ) (VAL1 FRAME 12-SECURITY) (VAL1 FRAME
          13-NATURAL ) (VAL1 FRAME 14-EXTERNAL) (VAL1 FRAME 15-INTERNAL)
          ) "Site Area Emergency" ) ) :TAB 2 "Site Area Emergency" )

RULE281
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  DOBEFORE :: (RULE213 RULE214 RULE215 RULE216 RULE286 RULE279 RULE280)
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :ATTR (QUOTE (YELLOW)) :TAB 8 (E (BAR-GRAPH (LIST (VAL1
          FRAME 01-RELEASE ) (VAL1 FRAME 02-FPBARRIER) (VAL1 FRAME
          03-STEAM ) (VAL1 FRAME 04-PRIMARY) (VAL1 FRAME 05-POWER) (VAL1
          FRAME 06-FEEDWATER ) (VAL1 FRAME 07-OTHER) (VAL1 FRAME
          08-RPS-FAIL ) (VAL1 FRAME 09-FUEL) (VAL1 FRAME 10-CR-EVAC) (
          VAL1 FRAME 11-FIRE ) (VAL1 FRAME 12-SECURITY) (VAL1 FRAME
          13-NATURAL ) (VAL1 FRAME 14-EXTERNAL) (VAL1 FRAME 15-INTERNAL)
          ) "Alert" ) ) :TAB 2 "Alert" )

RULE282
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  DOBEFORE :: (RULE213 RULE214 RULE215 RULE216 RULE279 RULE286 RULE280
              RULE281 )
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :ATTR (QUOTE (CYAN)) :TAB 8 (E (BAR-GRAPH (LIST (VAL1
          FRAME 01-RELEASE ) (VAL1 FRAME 02-FPBARRIER) (VAL1 FRAME
          03-STEAM ) (VAL1 FRAME 04-PRIMARY) (VAL1 FRAME 05-POWER) (VAL1
          FRAME 06-FEEDWATER ) (VAL1 FRAME 07-OTHER) (VAL1 FRAME
          08-RPS-FAIL ) (VAL1 FRAME 09-FUEL) (VAL1 FRAME 10-CR-EVAC) (
          VAL1 FRAME 11-FIRE ) (VAL1 FRAME 12-SECURITY) (VAL1 FRAME
          13-NATURAL ) (VAL1 FRAME 14-EXTERNAL) (VAL1 FRAME 15-INTERNAL)
          ) "Unusual Event" ) ) :TAB 2 "Unusual Event" )
```

```
RULE283
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  DOBEFORE :: (RULE286 RULE213 RULE214 RULE215 RULE216 RULE279 RULE280
               RULE281 RULE282 )
  IF    :: (STATUS IS KNOWN)
  THEN :: (PRINT :ATTR (QUOTE (WHITE)) :TAB 8 (E (BAR-GRAPH (LIST (VAL1
           FRAME 01-RELEASE ) (VAL1 FRAME 02-FPBARRIER) (VAL1 FRAME
           03-STEAM ) (VAL1 FRAME 04-PRIMARY) (VAL1 FRAME 05-POWER) (VAL1
           FRAME 06-FEEDWATER ) (VAL1 FRAME 07-OTHER) (VAL1 FRAME
           08-RPS-FAIL ) (VAL1 FRAME 09-FUEL) (VAL1 FRAME 10-CR-EVAC) (
           VAL1 FRAME 11-FIRE ) (VAL1 FRAME 12-SECURITY) (VAL1 FRAME
           13-NATURAL ) (VAL1 FRAME 14-EXTERNAL) (VAL1 FRAME 15-INTERNAL)
           ) "No Emergency Declared" ) ) :TAB 2 "No Emergency" :LINE "
           Module:   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15" )

RULE285
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  DOBEFORE :: (RULE286 RULE213 RULE214 RULE215 RULE216 RULE279 RULE280
               RULE281 RULE282 RULE283 )
  IF    :: (STATUS IS KNOWN)
  THEN :: (SET-OPTIONS NO-PROMPT NO-RETURN-KEY AND PRINT :ATTR (QUOTE (
           GREEN ) ) "Elapsed Time:  " CLOCK " seconds" AND DATA-MGMT )

RULE286
=======
  SUBJECT :: CLASSIFY-RULES
  ANTECEDENT :: YES
  IF    :: (STATUS = No Emergency Declared)
  THEN :: (PRINT :LINE :ATTR (QUOTE (blink red)) "Press [ALT] then [F8]
           once..." AND PRINT :HOLD/CLEAR :ATTR (QUOTE (WHITE)) :ROW 1
    "
    "
    "
    "
    "
    "
  :LINE )


  ========================
     EP-MODULE-15-RULES
  ========================

RULE100
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 1"
  IF    :: (! INT-TURBINE-SD)
  THEN :: (MOD15-STEP1 = No Emergency Declared)

RULE101
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 2"
  IF    :: (INT-TURBINE-SD AND ! INT-TURBINE-CP)
  THEN :: (MOD15-STEP1 = Unusual Event)
```

```
RULE102
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 2"
  IF    :: (INT-TURBINE-SD AND INT-TURBINE-CP)
  THEN :: (MOD15-STEP1 = Alert)

RULE103
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 3"
  IF    :: (! INT-OTHER1)
  THEN :: (MOD15-STEP3 = No Emergency Declared)

RULE104
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 3"
  IF    :: (INT-OTHER1 AND ! INT-OTHER2)
  THEN :: (MOD15-STEP3 = Unusual Event)

RULE105
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 4"
  IF    :: (INT-OTHER1 AND INT-OTHER2 AND ! INT-OTHER3)
  THEN :: (MOD15-STEP3 = Alert)

RULE106
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15 - Step 5"
  IF    :: (INT-OTHER1 AND INT-OTHER2 AND INT-OTHER3)
  THEN :: (MOD15-STEP3 = Site Area Emergency)

RULE107
=======
  SUBJECT :: EP-MODULE-15-RULES
  COMMENT :: "Module 15"
  IF    :: (FINDOUT MOD15-STEP1 AND FINDOUT MOD15-STEP3)
  THEN :: (15-INTERNAL = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD15-STEP1)
           (VAL1 FRAME MOD15-STEP3 ) ) ) ) )


  ========================
     EP-MODULE-14-RULES
  ========================

RULE091
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 1"
  IF    :: (! EXT-EXIST)
  THEN :: (MOD14-STEP1 = No Emergency Declared)

RULE092
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 1"
  IF    :: (EXT-EXIST AND ! EXT-SERIOUS-DMG)
  THEN :: (MOD14-STEP1 = Unusual Event)
```

```
RULE093
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 2"
  IF    :: (EXT-EXIST AND EXT-SERIOUS-DMG AND ! EXT-SEVERE-DMG)
  THEN :: (MOD14-STEP1 = Alert)

RULE094
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 3"
  IF    :: (EXT-EXIST AND EXT-SERIOUS-DMG AND EXT-SEVERE-DMG)
  THEN :: (MOD14-STEP1 = Site Area Emergency)

RULE095
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 4"
  IF    :: (! EXT-TOXIC1)
  THEN :: (MOD14-STEP4 = No Emergency Declared)

RULE096
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 4"
  IF    :: (EXT-TOXIC1 AND ! EXT-TOXIC2)
  THEN :: (MOD14-STEP4 = Unusual Event)

RULE097
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 5"
  IF    :: (EXT-TOXIC1 AND EXT-TOXIC2 AND ! EXT-TOXIC3)
  THEN :: (MOD14-STEP4 = Alert)

RULE098
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14 - Step 6"
  IF    :: (EXT-TOXIC1 AND EXT-TOXIC2 AND EXT-TOXIC3)
  THEN :: (MOD14-STEP4 = Site Area Emergency)

RULE099
=======
  SUBJECT :: EP-MODULE-14-RULES
  COMMENT :: "Module 14"
  IF    :: (FINDOUT MOD14-STEP1 AND FINDOUT MOD14-STEP4)
  THEN :: (14-EXTERNAL = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD14-STEP1)
           (VAL1 FRAME MOD14-STEP4 ) ) ) ) )


  ========================
     EP-MODULE-13-RULES
  ========================

RULE087
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 1"
  IF    :: (! NAT-UNUSUAL)
  THEN :: (13-NATURAL = No Emergency Declared)
```

```
RULE088
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 1.1"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Earthquake" AND NAT-EQUAKE =
            UNUSUAL )
  THEN :: (13-NATURAL = Unusual Event)

RULE089
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 2.1"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Earthquake" AND NAT-EQUAKE =
            SERIOUS )
  THEN :: (13-NATURAL = Alert)

RULE090
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 3.1"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = Earthquake AND NAT-EQUAKE = SEVERE)
  THEN :: (13-NATURAL = Site Area Emergency)

RULE114
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 1.2"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Flood or Wave Surge" AND NAT-FLOOD
            = UNUSUAL )
  THEN :: (13-NATURAL = Unusual Event)

RULE115
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 2.2"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Flood or Wave Surge" AND NAT-FLOOD
            = SERIOUS )
  THEN :: (13-NATURAL = Alert)

RULE116
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 3.2"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Flood or Wave Surge" AND NAT-FLOOD
            = SEVERE )
  THEN :: (13-NATURAL = Site Area Emergency)

RULE117
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 2.3"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = Tornado AND NAT-TORNADO)
  THEN :: (13-NATURAL = Alert)

RULE118
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 1.3"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = Tornado AND ! NAT-TORNADO)
  THEN :: (13-NATURAL = Unusual Event)
```

```
RULE119
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 1.4"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = UNUSUAL)
  THEN :: (13-NATURAL = Unusual Event)

RULE120
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 2.4"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = SERIOUS)
  THEN :: (13-NATURAL = Alert)

RULE121
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 3.3"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = SEVERE)
  THEN :: (13-NATURAL = Site Area Emergency)

RULE122
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 1.5"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Volcano-related Events" AND
            NAT-VOLCANO = UNUSUAL )
  THEN :: (13-NATURAL = Unusual Event)

RULE123
=======
  SUBJECT :: EP-MODULE-13-RULES
  COMMENT :: "Module 13 - Step 2.5"
  IF    :: (NAT-UNUSUAL AND NAT-TYPE = "Volcano-related Events" AND
            NAT-VOLCANO = SERIOUS )
  THEN :: (13-NATURAL = Alert)


  ========================
     EP-MODULE-12-RULES
  ========================

RULE082
=======
  SUBJECT :: EP-MODULE-12-RULES
  COMMENT :: "Module 12 - Step 1"
  IF    :: (! SECURITY-ALERT)
  THEN :: (12-SECURITY = No Emergency Declared)

RULE083
=======
  SUBJECT :: EP-MODULE-12-RULES
  COMMENT :: "Module 12 - Step 1"
  IF    :: (SECURITY-ALERT AND ! SEC-ADV-ATTACK)
  THEN :: (12-SECURITY = Unusual Event)

RULE084
=======
  SUBJECT :: EP-MODULE-12-RULES
  COMMENT :: "Module 12 - Step 2"
  IF    :: (SECURITY-ALERT AND SEC-ADV-ATTACK AND ! SEC-CONTROL1)
  THEN :: (12-SECURITY = Alert)
```

```
RULE085
=======
  SUBJECT :: EP-MODULE-12-RULES
  COMMENT :: "Module 12 - Step 3"
  IF    :: (SECURITY-ALERT AND SEC-ADV-ATTACK AND SEC-CONTROL1 AND !
            SEC-CONTROL2 )
  THEN :: (12-SECURITY = Site Area Emergency)

RULE086
=======
  SUBJECT :: EP-MODULE-12-RULES
  COMMENT :: "Module 12 - Step 4"
  IF    :: (SECURITY-ALERT AND SEC-ADV-ATTACK AND SEC-CONTROL1 AND
            SEC-CONTROL2 )
  THEN :: (12-SECURITY = General Emergency)


  ========================
     EP-MODULE-11-RULES
  ========================

RULE078
=======
  SUBJECT :: EP-MODULE-11-RULES
  COMMENT :: "Module 11 - Step 1"
  IF    :: (! FIRE)
  THEN :: (11-FIRE = No Emergency Declared)

RULE079
=======
  SUBJECT :: EP-MODULE-11-RULES
  COMMENT :: "Module 11 - Step 1"
  IF    :: (FIRE AND ! FIRE-SAFETY1)
  THEN :: (11-FIRE = Unusual Event)

RULE080
=======
  SUBJECT :: EP-MODULE-11-RULES
  COMMENT :: "Module 11 - Step 2"
  IF    :: (FIRE AND FIRE-SAFETY1 AND ! FIRE-SAFETY2)
  THEN :: (11-FIRE = Alert)

RULE081
=======
  SUBJECT :: EP-MODULE-11-RULES
  COMMENT :: "Module 11 - Step 3"
  IF    :: (FIRE AND FIRE-SAFETY1 AND FIRE-SAFETY2)
  THEN :: (11-FIRE = Site Area Emergency)


  ========================
     EP-MODULE-10-RULES
  ========================

RULE075
=======
  SUBJECT :: EP-MODULE-10-RULES
  COMMENT :: "Module 10 - Step 1"
  IF    :: (! CR-EVAC)
  THEN :: (10-CR-EVAC = No Emergency Declared)
```

```
RULE076
=======
  SUBJECT :: EP-MODULE-10-RULES
  COMMENT :: "Module 10 - Step 1"
  IF    :: (CR-EVAC AND ! CR-EVAC-NO-SD)
  THEN :: (10-CR-EVAC = Alert)

RULE077
=======
  SUBJECT :: EP-MODULE-10-RULES
  COMMENT :: "Module 10 - Step 2"
  IF    :: (CR-EVAC AND CR-EVAC-NO-SD)
  THEN :: (10-CR-EVAC = Site Area Emergency)


  ========================
     EP-MODULE-09-RULES
  ========================

RULE069
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 1"
  IF    :: (! SF-POOL-LOW)
  THEN :: (MOD9-STEP1 = No Emergency Declared)

RULE070
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 1"
  IF    :: (SF-POOL-LOW)
  THEN :: (MOD9-STEP1 = Unusual Event)

RULE071
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 2"
  IF    :: (! FUEL-HANDLING)
  THEN :: (MOD9-STEP2 = No Emergency Declared)

RULE072
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 2.1"
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Containment" AND PRM1-HI AND
            ! FUEL-NUMBER )
  THEN :: (MOD9-STEP2 = Alert)

RULE073
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 3.1"
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Containment" AND PRM1-HI AND
            FUEL-NUMBER )
  THEN :: (MOD9-STEP2 = Site Area Emergency)

RULE074
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9"
  IF    :: (FINDOUT MOD9-STEP1 AND FINDOUT MOD9-STEP2)
  THEN :: (09-FUEL = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD9-STEP1) (VAL1
            FRAME MOD9-STEP2 ) ) ) ) )
```

```
RULE124
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 2.1"
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = Containment AND ! PRM1-HI)
  THEN :: (MOD9-STEP2 = No Emergency Declared)

RULE125
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 3.2"
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Fuel Building" AND (PRM2-HI
           OR PRM3-HI OR ARM12/13-HI ) AND FUEL-NUMBER )
  THEN :: (MOD9-STEP2 = Site Area Emergency)

RULE126
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Steps 2.2 and 2.3"
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Fuel Building" AND (PRM2-HI
           OR PRM3-HI OR ARM12/13-HI ) AND ! FUEL-NUMBER )
  THEN :: (MOD9-STEP2 = Alert)

RULE127
=======
  SUBJECT :: EP-MODULE-09-RULES
  COMMENT :: "Module 9 - Step 2"
  IF    :: (FUEL-HANDLING AND FUEL-DMG-LOC = "Fuel Building" AND ! PRM2-HI
           AND ! PRM3-HI AND ! ARM12/13-HI )
  THEN :: (MOD9-STEP2 = No Emergency Declared)

RULE331
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1000 > 3.9e7 AND PRM1-MODE = Pressure Relief Mode)
  THEN :: (PRM-1A)

RULE332
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1001 > 3500000. AND PRM1-MODE = Pressure Relief Mode)
  THEN :: (PRM-1B)

RULE333
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1008 > 830.)
  THEN :: (PRM2-HI)

RULE334
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (PRM-2A)
  THEN :: (PRM2-HI)

RULE335
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1005 > 52000.)
  THEN :: (PRM-2A)
```

```
RULE336
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (PRM-2B)
  THEN :: (PRM2-HI)

RULE337
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1006 > 4700.)
  THEN :: (PRM-2B)

RULE338
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1009 > 90000.)
  THEN :: (PRM3-HI)

RULE339
=======
  SUBJECT :: EP-MODULE-09-RULES
  IF    :: (R1049 > 15 OR R1050 > 15)
  THEN :: (ARM12/13-HI)


  ========================
     EP-MODULE-08-RULES
  ========================

RULE065
=======
  SUBJECT :: EP-MODULE-08-RULES
  COMMENT :: "Module 8 - Step 1"
  IF    :: (! RPS-RX-CRITICAL)
  THEN :: (08-RPS-FAIL = No Emergency Declared)

RULE066
=======
  SUBJECT :: EP-MODULE-08-RULES
  COMMENT :: "Module 8 - Step 1"
  IF    :: (RPS-RX-CRITICAL AND ! TRANSIENT)
  THEN :: (08-RPS-FAIL = Alert)

RULE067
=======
  SUBJECT :: EP-MODULE-08-RULES
  COMMENT :: "Module 8 - Step 2"
  IF    :: (RPS-RX-CRITICAL AND TRANSIENT AND ! RPS-CORE-DMG)
  THEN :: (08-RPS-FAIL = Site Area Emergency)

RULE068
=======
  SUBJECT :: EP-MODULE-08-RULES
  COMMENT :: "Module 8 - Step 3"
  IF    :: (RPS-RX-CRITICAL AND TRANSIENT AND RPS-CORE-DMG)
  THEN :: (08-RPS-FAIL = General Emergency)

RULE229
=======
  SUBJECT :: EP-MODULE-08-RULES
  COMMENT :: "Module 8 - Step 3.4a"
  IF    :: (5-CE-TC = > 1200 degrees F)
  THEN :: (RPS-CORE-DMG)
```

```
RULE230
=======
  SUBJECT :: EP-MODULE-08-RULES
  COMMENT :: "Module 8 - Step 3.4b"
  IF    :: (5-CE-TC = > 714 degrees F AND RVLIS)
  THEN :: (RPS-CORE-DMG)


  ========================
     EP-MODULE-07-RULES
  ========================

RULE050
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1"
  IF    :: (! LMT-CONT-INTEG)
  THEN :: (MOD7-STEP1 = No Emergency Declared)

RULE051
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1"
  IF    :: (LMT-CONT-INTEG)
  THEN :: (MOD7-STEP1 = Unusual Event)

RULE052
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 2"
  IF    :: (! LMT-ESF/FIREP)
  THEN :: (MOD7-STEP2 = No Emergency Declared)

RULE053
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 2"
  IF    :: (LMT-ESF/FIREP)
  THEN :: (MOD7-STEP2 = Unusual Event)

RULE054
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 3"
  IF    :: (! LMT-ECCS)
  THEN :: (MOD7-STEP3 = No Emergency Declared)

RULE055
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 3"
  IF    :: (LMT-ECCS)
  THEN :: (MOD7-STEP3 = Unusual Event)

RULE056
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 4"
  IF    :: (! LMT-INJURY)
  THEN :: (MOD7-STEP4 = No Emergency Declared)
```

```
RULE057
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 4"
  IF    :: (LMT-INJURY)
  THEN :: (MOD7-STEP4 = Unusual Event)

RULE058
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5"
  IF    :: (! LMT-ACTIVITY)
  THEN :: (MOD7-STEP5 = No Emergency Declared)

RULE059
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5"
  IF    :: (LMT-ACTIVITY)
  THEN :: (MOD7-STEP5 = Alert)

RULE060
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 6"
  IF    :: (! LMT-COLD-SD)
  THEN :: (MOD7-STEP6 = No Emergency Declared)

RULE061
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 6"
  IF    :: (LMT-COLD-SD)
  THEN :: (MOD7-STEP6 = Alert)

RULE062
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 7"
  IF    :: (! LMT-HOT-SD)
  THEN :: (MOD7-STEP7 = No Emergency Declared)

RULE063
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 7"
  IF    :: (LMT-HOT-SD)
  THEN :: (MOD7-STEP7 = Site Area Emergency)

RULE064
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7"
  IF    :: (FINDOUT MOD7-STEP1 AND FINDOUT MOD7-STEP2 AND FINDOUT
          MOD7-STEP3 AND FINDOUT MOD7-STEP4 AND FINDOUT MOD7-STEP5 AND
          FINDOUT MOD7-STEP6 AND FINDOUT MOD7-STEP7 )
  THEN :: (07-OTHER = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD7-STEP1) (
          VAL1 FRAME MOD7-STEP2 ) (VAL1 FRAME MOD7-STEP3) (VAL1 FRAME
          MOD7-STEP4 ) (VAL1 FRAME MOD7-STEP5) (VAL1 FRAME MOD7-STEP6) (
          VAL1 FRAME MOD7-STEP7 ) ) ) ) )
```

```
RULE199
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 3.1"
  IF    :: (SIS AND SIS-FLOW)
  THEN :: (LMT-ECCS)

RULE200
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.1"
  IF    :: (ARMS-HI1)
  THEN :: (LMT-ACTIVITY)

RULE201
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.2"
  IF    :: (ARMS-HI2)
  THEN :: (LMT-ACTIVITY)

RULE202
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.3"
  IF    :: (ARMS-HI3)
  THEN :: (LMT-ACTIVITY)

RULE203
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.4"
  IF    :: (ARMS-HI4)
  THEN :: (LMT-ACTIVITY)

RULE204
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.7"
  IF    :: (ARM-15 = > 100 R/hr, High alarm)
  THEN :: (LMT-ACTIVITY)

RULE205
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.5"
  IF    :: (ARM-20 = "> 25 R/hr [Refueling]" OR ARM-20 = "> 200 R/hr [Power
           Operation]" )
  THEN :: (LMT-ACTIVITY)

RULE206
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.6"
  IF    :: (ARM-21)
  THEN :: (LMT-ACTIVITY)

RULE207
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 5.8"
  IF    :: (AIRBN-ACT)
  THEN :: (LMT-ACTIVITY)
```

```
RULE208
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 6"
  IF    :: (! RHR AND ! NAT-CIRC AND RCS-T-HI2)
  THEN :: (LMT-COLD-SD)

RULE209
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 7.1"
  IF    :: (RT AND ! HPI)
  THEN :: (LMT-HOT-SD)

RULE210
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 7.2"
  IF    :: (RT AND ! AFW)
  THEN :: (LMT-HOT-SD)

RULE211
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 7.3"
  IF    :: (! RHR AND MODE-4 AND ! AFW)
  THEN :: (LMT-HOT-SD)

RULE316
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1.1"
  IF    :: (IV-FAIL)
  THEN :: (LMT-CONT-INTEG)

RULE317
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1.2"
  IF    :: (HATCH-FAIL)
  THEN :: (LMT-CONT-INTEG)

RULE318
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1.3"
  IF    :: (DOOR-FAIL)
  THEN :: (LMT-CONT-INTEG)

RULE319
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1.4"
  IF    :: (CONT-LEAK-1)
  THEN :: (LMT-CONT-INTEG)

RULE320
=======
  SUBJECT :: EP-MODULE-07-RULES
  COMMENT :: "Module 7 - Step 1.5"
  IF    :: (CONT-LEAK-2)
  THEN :: (LMT-CONT-INTEG)
```

```
RULE321
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1038 > 2.5 OR R1039 > 2.5 OR R1040 > 2.5 OR R1041 > 2.5 OR
            R1042 > 2.5 )
  THEN :: (ARMS-HI1)

RULE322
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1044 > 2.5 OR R1045 > 2.5 OR R1046 > 2.5 OR R1047 > 2.5)
  THEN :: (ARMS-HI1)

RULE323
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1049 > 2.5 OR R1050 > 2.5 OR R1051 > 2.5)
  THEN :: (ARMS-HI1)

RULE324
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1043 > 100 OR R1054 > 100 OR R1055 > 100)
  THEN :: (ARMS-HI2)

RULE325
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1048 > 10)
  THEN :: (ARMS-HI3)

RULE326
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1056 > 15 OR R1057 > 15)
  THEN :: (ARMS-HI4)

RULE327
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1058 IS KNOWN AND OPERATION = Refueling)
  THEN :: (ARM-20 = (E (SELECT-ITEM (VAL1 FRAME R1058) (QUOTE (10. 25.))
            (QUOTE ("Less than 10 R/hr" "> 10 R/hr, High alarm" "> 25 R/hr
            [Refueling]" ) ) ) ) )

RULE328
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1058 IS KNOWN AND OPERATION = Power Operations)
  THEN :: (ARM-20 = (E (SELECT-ITEM (VAL1 FRAME R1058) (QUOTE (10. 200.))
            (QUOTE ("Less than 10 R/hr" "> 10 R/hr, High alarm" "> 200 R/hr
            [Power Operation]" ) ) ) ) )

RULE329
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: ((R1059 > 15 AND OPERATION = Refueling) OR (R1059 > 100 AND
            OPERATION = "Power Operations" ) )
  THEN :: (ARM-21)
```

```
RULE330
=======
  SUBJECT :: EP-MODULE-07-RULES
  IF    :: (R1052 > 100 OR R1053 > 100)
  THEN :: (ARM-15 = > 100 R/hr, High alarm)


  ========================
     EP-MODULE-06-RULES
  ========================

RULE045
=======
  SUBJECT :: EP-MODULE-06-RULES
  COMMENT :: "Module 6 - Step 1"
  IF    :: (! AFW-NO-PUMPS)
  THEN :: (06-FEEDWATER = No Emergency Declared)

RULE046
=======
  SUBJECT :: EP-MODULE-06-RULES
  COMMENT :: "Module 6 - Step 2"
  IF    :: (AFW-NO-PUMPS AND ! AFW-RT1)
  THEN :: (06-FEEDWATER = Unusual Event)

RULE047
=======
  SUBJECT :: EP-MODULE-06-RULES
  COMMENT :: "Module 6 - Step 3"
  IF    :: (AFW-NO-PUMPS AND AFW-RT1 AND ! AFW-RT2)
  THEN :: (06-FEEDWATER = Alert)

RULE048
=======
  SUBJECT :: EP-MODULE-06-RULES
  COMMENT :: "Module 6 - Step 4"
  IF    :: (AFW-NO-PUMPS AND AFW-RT1 AND AFW-RT2 AND ! AFW-RT3)
  THEN :: (06-FEEDWATER = Site Area Emergency)

RULE049
=======
  SUBJECT :: EP-MODULE-06-RULES
  COMMENT :: "Module 6 - Step 4"
  IF    :: (AFW-NO-PUMPS AND AFW-RT1 AND AFW-RT2 AND AFW-RT3)
  THEN :: (06-FEEDWATER = General Emergency)

RULE198
=======
  SUBJECT :: EP-MODULE-06-RULES
  IF    :: (RT-M/A AND SG-LVL-DC AND AFW-NF)
  THEN :: (AFW-RT1)

RULE315
=======
  SUBJECT :: EP-MODULE-06-RULES
  IF    :: (F1059 < 0.1 AND F1060 < 0.1 AND F1061 < 0.1 AND F1062 < 0.1
            AND RT-2MIN )
  THEN :: (AFW-NF AND AFW-NO-PUMPS)
```

```
  ========================
     EP-MODULE-05-RULES
  ========================

RULE033
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 1"
  IF    :: (! PWR-LOSS-TS)
  THEN :: (MOD5-STEP1 = No Emergency Declared)

RULE034
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 1"
  IF    :: (PWR-LOSS-TS AND ! PWR-OFF/AC)
  THEN :: (MOD5-STEP1 = Unusual Event)

RULE035
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 2"
  IF    :: (PWR-LOSS-TS AND PWR-OFF/AC AND ! PWR-LOSS-30)
  THEN :: (MOD5-STEP1 = Alert)

RULE036
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 3"
  IF    :: (PWR-LOSS-TS AND PWR-OFF/AC AND PWR-LOSS-30 AND ! PWR-LOSS-FW)
  THEN :: (MOD5-STEP1 = Site Area Emergency)

RULE037
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 4"
  IF    :: (PWR-LOSS-TS AND PWR-OFF/AC AND PWR-LOSS-30 AND PWR-LOSS-FW)
  THEN :: (MOD5-STEP1 = General Emergency)

RULE038
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 5"
  IF    :: (! PWR-ON-DC)
  THEN :: (MOD5-STEP5 = No Emergency Declared)

RULE039
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 5"
  IF    :: (PWR-ON-DC AND ! PWR-ON-DC-15)
  THEN :: (MOD5-STEP5 = Alert)

RULE040
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 6"
  IF    :: (PWR-ON-DC AND PWR-ON-DC-15)
  THEN :: (MOD5-STEP5 = Site Area Emergency)
```

```
RULE041
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 7"
  IF    :: (! ALARM-LOSS)
  THEN :: (MOD5-STEP7 = No Emergency Declared)

RULE042
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 7"
  IF    :: (ALARM-LOSS AND ! TRANSIENT)
  THEN :: (MOD5-STEP7 = Alert)

RULE043
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 8"
  IF    :: (ALARM-LOSS AND TRANSIENT)
  THEN :: (MOD5-STEP7 = Site Area Emergency)

RULE044
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5"
  IF    :: (FINDOUT MOD5-STEP1 AND FINDOUT MOD5-STEP5 AND FINDOUT
            MOD5-STEP7 )
  THEN :: (05-POWER = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD5-STEP1) (
            VAL1 FRAME MOD5-STEP5 ) (VAL1 FRAME MOD5-STEP7) ) ) ) )

RULE194
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 1.1"
  IF    :: (PWR-UV-2 = "Undervoltage alarms on both buses" AND (PWR-UV = "
            > 24 hours" OR PWR-UV = "> 72 hours" ) )
  THEN :: (PWR-LOSS-TS)

RULE195
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 1.3"
  IF    :: (PWR-DG-LOSS = "One EDG unavailable for > 12 hours" AND (PWR-UV
            = "> 12 hours" OR PWR-UV = "> 24 hours" OR PWR-UV = "> 72 hours"
            ) AND (PWR-UV-2 = "Undervoltage alarm on one bus" OR PWR-UV-2
            = "Undervoltage alarm on both buses" ) )
  THEN :: (PWR-LOSS-TS)

RULE196
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 2.1"
  IF    :: (! PWR-ESF AND PWR-UV-2 = "Undervoltage alarms on both buses"
            AND PWR-UV = "> 5 minutes" )
  THEN :: (PWR-OFF/AC)
```

```
RULE197
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 3.1"
  IF    :: (! PWR-ESF AND PWR-UV-2 = "Undervoltage alarms on both buses"
            AND (PWR-UV = "> 30 minutes" OR PWR-UV = "> 12 hours" OR
            PWR-UV = "> 24 hours" OR PWR-UV = "> 72 hours" ) )
  THEN :: (PWR-OFF/AC AND PWR-LOSS-30)

RULE231
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 1.2"
  IF    :: (PWR-DG-LOSS = "Both EDGs unavailable for > 2 hours" OR
            PWR-DG-LOSS = "Both EDGs unavailable for > 72 hours" )
  THEN :: (PWR-LOSS-TS)

RULE287
=======
  SUBJECT :: EP-MODULE-05-RULES
  COMMENT :: "Module 5 - Step 1.4"
  IF    :: (PWR-DG-LOSS = "One EDG unavailable for > 72 hours" AND PWR-UV
            = "> 72 hours" AND (PWR-UV-2 = "Undervoltage alarm on one bus"
            OR PWR-UV-2 = "Undervoltage alarm on both buses" ) )
  THEN :: (PWR-LOSS-TS)


  ========================
     EP-MODULE-04-RULES
  ========================

RULE021
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 1"
  IF    :: (! LKG-P/S-TS)
  THEN :: (MOD4-STEP1 = No Emergency Declared)

RULE022
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 1"
  IF    :: (LKG-P/S-TS AND ! LKG-SGT)
  THEN :: (MOD4-STEP1 = Unusual Event)

RULE023
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 2"
  IF    :: (LKG-P/S-TS AND LKG-SGT AND ! LKG-SGT-LOP AND ! LKG-SGT-SVFR)
  THEN :: (MOD4-STEP1 = Alert)

RULE024
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 4"
  IF    :: (LKG-P/S-TS AND LKG-SGT AND ! LKG-SGT-LOP AND LKG-SGT-SVFR)
  THEN :: (MOD4-STEP1 = Site Area Emergency)
```

```
RULE025
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 3"
  IF    :: (LKG-P/S-TS AND LKG-SGT AND LKG-SGT-LOP)
  THEN :: (MOD4-STEP1 = Site Area Emergency)

RULE026
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Steps 5 and 6"
  IF    :: (! LKG-P-TS AND ! ST/P-VLV-RESEAT)
  THEN :: (MOD4-STEP5/6 = No Emergency Declared)

RULE027
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Steps 5 and 6"
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND ! LKG-COOLANT)
  THEN :: (MOD4-STEP5/6 = Unusual Event)

RULE028
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 7"
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND !
             LOCA-CHG-PMP )
  THEN :: (MOD4-STEP5/6 = Alert)

RULE029
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 8"
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND LOCA-CHG-PMP
             AND ! LOCA-CHR-FAIL AND ! LOCA-ECCS-FAIL )
  THEN :: (MOD4-STEP5/6 = Site Area Emergency)

RULE030
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 9"
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND LOCA-CHG-PMP
             AND LOCA-CHR-FAIL )
  THEN :: (MOD4-STEP5/6 = General Emergency)

RULE031
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 10"
  IF    :: ((LKG-P-TS OR ST/P-VLV-RESEAT) AND LKG-COOLANT AND LOCA-CHG-PMP
             AND ! LOCA-CHR-FAIL AND LOCA-ECCS-FAIL )
  THEN :: (MOD4-STEP5/6 = General Emergency)

RULE032
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4"
  IF    :: (FINDOUT MOD4-STEP1 AND FINDOUT MOD4-STEP5/6)
  THEN :: (04-PRIMARY = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD4-STEP1) (
             VAL1 FRAME MOD4-STEP5/6 ) ) ) ) )
```

```
RULE187
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 6.1"
  IF    :: (PRV-OPEN)
  THEN :: (ST/P-VLV-RESEAT)

RULE188
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 2.1"
  IF    :: ((PRM-10 = ">3.7E3 cpm, High alarm" OR PRM-10 = ">3.7E4 cpm" OR
           PRM-16 OR PRM-6B = ">1.8E2 cpm, High alarm" OR PRM-6B = ">1.8E3
           cpm" OR PRM-6B = ">1.8E5 cpm for 0.5 hr" OR PRM-6B = "Off-scale
           for 2 minutes" ) AND RT-LOW-P )
  THEN :: (LKG-SGT)

RULE189
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 3.1"
  IF    :: (LKG-SGT AND PWR-UV-1 AND CR-LIGHTS)
  THEN :: (LKG-SGT-LOP)

RULE190
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 4.2"
  IF    :: (LKG-SGT AND PRV-OPEN)
  THEN :: (LKG-SGT-SVFR)

RULE191
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 4.1"
  IF    :: (LKG-SGT AND SG-VLV-O2)
  THEN :: (LKG-SGT-SVFR)

RULE192
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 9.1"
  IF    :: (LOCA-CHG-PMP AND CONT-P = "Approaching 60 psig" AND ECCS AND
           CONT-COOL )
  THEN :: (LOCA-CHR-FAIL)

RULE193
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Steps 10.1, 10.2, 10.3, 10.4"
  IF    :: (LOCA-CHG-PMP AND (5-CE-TC = "> 1200 degrees F" OR (5-CE-TC = "
           > 714 degrees F" AND ! RCP-OP AND RVLIS ) ) AND ARM-15 = "> 100
           R/hr, High alarm" AND ECCS-FAIL )
  THEN :: (LOCA-ECCS-FAIL)

RULE224
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 5.1"
  IF    :: (PB-LEAK)
  THEN :: (LKG-P-TS)
```

```
RULE225
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 5.2"
  IF    :: (LKG-UNID)
  THEN :: (LKG-P-TS)

RULE226
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Steps 5.3, 5.4, 5.5"
  IF    :: (LKG-VER)
  THEN :: (LKG-P-TS)

RULE227
=======
  SUBJECT :: EP-MODULE-04-RULES
  COMMENT :: "Module 4 - Step 8.1"
  IF    :: (CONT-HIGH AND (RT-LOW-P OR RCS-P-UNC) AND ! IND-NOT-SEC)
  THEN :: (LOCA-CHG-PMP)


  ========================
     EP-MODULE-03-RULES
  ========================

RULE017
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Steps 1 and 2"
  IF    :: (! ST-SEC-DEPRES AND ! ST-VLV-RESEAT)
  THEN :: (03-STEAM = No Emergency Declared)

RULE018
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Steps 1 and 2"
  IF    :: ((ST-SEC-DEPRES OR ST-VLV-RESEAT) AND ! ST-LKG)
  THEN :: (03-STEAM = Unusual Event)

RULE019
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 3"
  IF    :: ((ST-SEC-DEPRES OR ST-VLV-RESEAT) AND ST-LKG AND ! ST-LKG-FD)
  THEN :: (03-STEAM = Alert)

RULE020
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 4"
  IF    :: ((ST-SEC-DEPRES OR ST-VLV-RESEAT) AND ST-LKG AND ST-LKG-FD)
  THEN :: (03-STEAM = Site Area Emergency)

RULE178
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 1.1"
  IF    :: (ST-FLOW-INC AND RCS-T&P AND (ST-HIGH-SIS OR ST-PD-SIS))
  THEN :: (ST-SEC-DEPRES)
```

```
RULE179
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 2.1"
  IF    :: (SG-VLV-01)
  THEN :: (ST-VLV-RESEAT)

RULE180
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 2.2"
  IF    :: (SG-FLOW-EXC)
  THEN :: (ST-VLV-RESEAT)

RULE181
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 3.1"
  IF    :: ((CONT-P = "> 3.5 psig, High alarm" OR CONT-P = "Approaching 60
           psig" ) AND (PRM1-HI OR ARM-15 = > 100 R/hr, High alarm) AND (
           ST-PD-SIS OR ST-HIGH-SIS ) )
  THEN :: (ST-LKG)

RULE182
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 3.2"
  IF    :: ((PRM-16 OR PRM-10 = ">3.7E3 cpm, High alarm" OR PRM-10 = "
           >3.7E4 cpm" OR PRM-6B = ">1.8E2 cpm, High alarm" OR PRM-6B = "
           >1.8E3 cpm" OR PRM-6B = ">1.8E5 cpm for 0.5 hr" OR PRM-6B = "
           Off-scale for 2 minutes" ) AND (ST-HIGH-SIS OR ST-PD-SIS) AND
           MSIV-F-SL )
  THEN :: (ST-LKG)

RULE183
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 4.1"
  IF    :: (ST-LKG AND I-131-PC > 300)
  THEN :: (ST-LKG-FD)

RULE184
=======
  SUBJECT :: EP-MODULE-03-RULES
  COMMENT :: "Module 3 - Step 4.2"
  IF    :: (ST-LKG AND PRM-13 AND (LAB-FF = "increased 1.0% in 30 minutes"
           OR LAB-FF = "increased to a total fraction of 5%" ) )
  THEN :: (ST-LKG-FD)


  ========================
     EP-MODULE-02-RULES
  ========================

RULE012
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Steps 1.0, 2.0"
  IF    :: (! FPB-FUEL AND ! FPB-COOLANT)
  THEN :: (MOD2-STEP1/2 = No Emergency Declared)
```

```
RULE013
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Steps 1.0, 2.0"
  IF    :: ((FPB-FUEL OR FPB-COOLANT) AND ! FPB-FUEL-DMG)
  THEN :: (MOD2-STEP1/2 = Unusual Event)

RULE014
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 3.0"
  IF    :: ((FPB-FUEL OR FPB-COOLANT) AND FPB-FUEL-DMG AND ! FPB-CORE)
  THEN :: (MOD2-STEP1/2 = Alert)

RULE015
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 4.0"
  IF    :: ((FPB-FUEL OR FPB-COOLANT) AND FPB-FUEL-DMG AND FPB-CORE)
  THEN :: (MOD2-STEP1/2 = General Emergency)

RULE016
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2"
  IF    :: (FINDOUT MOD2-STEP1/2 AND FINDOUT MOD2-STEP5)
  THEN :: (02-FPBARRIER = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD2-STEP1/2
           ) (VAL1 FRAME MOD2-STEP5) ) ) ) )

RULE163
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 1.1"
  IF    :: (PCT-TP > 80)
  THEN :: (I-LIMIT = 60)

RULE164
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 1.1"
  IF    :: (PCT-TP <= 80)
  THEN :: (I-LIMIT = (380 - (4 * PCT-TP)))

RULE165
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 3.1"
  IF    :: (I-131-PC > 300)
  THEN :: (FPB-FUEL AND FPB-FUEL-DMG)

RULE166
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 1.1"
  IF    :: (I-131-PC > I-LIMIT)
  THEN :: (FPB-FUEL)

RULE167
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 1.2"
  IF    :: (PRM-13 AND LAB-FF = increased 0.1% in 30 minutes)
  THEN :: (FPB-FUEL)
```

```
RULE168
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 3.2"
  IF    :: (LAB-FF = "increased 1% in 30 minutes" OR LAB-FF = "increased to
           a total fraction of 5%" )
  THEN :: (FPB-FUEL AND FPB-FUEL-DMG)

RULE169
=======
  SUBJECT :: EP-MODULE-02-RULES
  UTILITY :: 50
  COMMENT :: "Module 2 - Step 2.1"
  IF    :: (RCS-P = > 2385 psig)
  THEN :: (FPB-COOLANT)

RULE170
=======
  SUBJECT :: EP-MODULE-02-RULES
  UTILITY :: 50
  COMMENT :: "Module 2 - Step 2.3"
  IF    :: (RCS-P = Less than 1807 psig AND 5-CE-TC = > 620 degrees F)
  THEN :: (FPB-COOLANT)

RULE171
=======
  SUBJECT :: EP-MODULE-02-RULES
  UTILITY :: 50
  COMMENT :: "Module 2 - Step 3.3"
  IF    :: (5-CE-TC = > 714 degrees F)
  THEN :: (FPB-COOLANT AND FPB-FUEL-DMG)

RULE172
=======
  SUBJECT :: EP-MODULE-02-RULES
  UTILITY :: 50
  COMMENT :: "Module 2 - Step 4.1"
  IF    :: (5-CE-TC = > 1200 degrees F)
  THEN :: (FPB-COOLANT AND FPB-FUEL-DMG AND FPB-CORE)

RULE173
=======
  SUBJECT :: EP-MODULE-02-RULES
  UTILITY :: 50
  COMMENT :: "Module 2 - Step 2.2"
  IF    :: (RCS-T-HI)
  THEN :: (FPB-COOLANT)

RULE174
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 2.4"
  IF    :: (SM-ALARM)
  THEN :: (FPB-COOLANT)
```

```
RULE175
=======
  SUBJECT :: EP-MODULE-02-RULES
  UTILITY :: 50
  COMMENT :: "Module 2 - Step 6.1"
  IF    :: (FPB-FUEL-DMG AND CONT-P = "Approaching 60 psig" AND
            LOCA-CHG-PMP )
  THEN :: (FPB-LOSS-3)

RULE176
=======
  SUBJECT :: EP-MODULE-02-RULES
  IF    :: (CONT-P = Approaching 60 psig AND ARM-15 = > 2.0E3 mrem/hr)
  THEN :: (FPB-LOSS-3)

RULE177
=======
  SUBJECT :: EP-MODULE-02-RULES
  IF    :: (FPB-FUEL-DMG AND SG-TB-R AND MSIV-F-SG)
  THEN :: (FPB-LOSS-3)

RULE217
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 5"
  IF    :: (! FPB-LOSS-2)
  THEN :: (MOD2-STEP5 = No Emergency Declared)

RULE218
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Steps 5.1, 5.2, 5.3"
  IF    :: ((FPB-LOSS-1 AND LKG-COOLANT) OR (FPB-LOSS-1 AND LMT-CONT-INTEG
            ) OR (LKG-COOLANT AND LMT-CONT-INTEG) )
  THEN :: (FPB-LOSS-2)

RULE219
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2- Step 5"
  IF    :: (FPB-LOSS-1 AND FPB-LOSS-2 AND ! FPB-LOSS-3)
  THEN :: (MOD2-STEP5 = Site Area Emergency)

RULE220
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 6"
  IF    :: (FPB-LOSS-2 AND FPB-LOSS-3)
  THEN :: (MOD2-STEP5 = General Emergency)

RULE221
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 4.2"
  IF    :: (5-CE-TC = > 714 degrees F AND RVLIS AND ! RCP-OP)
  THEN :: (FPB-CORE)
```

```
RULE222
=======
  SUBJECT :: EP-MODULE-02-RULES
  COMMENT :: "Module 2 - Step 5.1; Module 2 branch point; Module 4 branch
             point"
  IF    :: (FPB-FUEL-DMG OR LMT-CONT-INTEG)
  THEN :: (FPB-LOSS-1)


  ========================
     EP-MODULE-01-RULES
  ========================

RULE002
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 1 [Entry Point]"
  IF    :: (! RLS-EXC-1HR)
  THEN :: (MOD1-STEP1 = No Emergency Declared)

RULE003
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 2"
  IF    :: (RLS-EXC-1HR AND ! RLS-NOT-CNTRL)
  THEN :: (MOD1-STEP1 = Unusual Event)

RULE004
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 3"
  IF    :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND ! RLS-LIMIT1-1)
  THEN :: (MOD1-STEP1 = Alert)

RULE005
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7"
  IF    :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1 AND !
             RLS-LIMIT2 )
  THEN :: (MOD1-STEP1 = Site Area Emergency)

RULE006
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7"
  IF    :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1 AND RLS-LIMIT2)
  THEN :: (MOD1-STEP1 = General Emergency)

RULE007
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 4 [Entry Point]"
  IF    :: (! RLS-EAB)
  THEN :: (MOD1-STEP4 = No Emergency Declared)

RULE008
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 5"
  IF    :: (RLS-EAB AND ! RLS-LIMIT1-2)
  THEN :: (MOD1-STEP4 = Alert)
```

```
RULE009
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7"
  IF    :: (RLS-EAB AND RLS-LIMIT1-2 AND ! RLS-LIMIT2)
  THEN :: (MOD1-STEP4 = Site Area Emergency)

RULE010
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7"
  IF    :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)
  THEN :: (MOD1-STEP4 = General Emergency)

RULE011
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Select Most Severe Classification from 3 Entry
              Points"
  IF    :: (FINDOUT MOD1-STEP1 AND FINDOUT MOD1-STEP4 AND FINDOUT
             MOD1-STEP6 )
  THEN :: (01-RELEASE = (E (SEVERE-CLASS (LIST (VAL1 FRAME MOD1-STEP1) (
             VAL1 FRAME MOD1-STEP4 ) (VAL1 FRAME MOD1-STEP6) ) ) ) )

RULE130
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 1.1"
  IF    :: (PRM-1C = >9.9E3 cpm)
  THEN :: (RLS-EXC-1HR)

RULE131
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 1.5"
  IF    :: (PRM-9 = > High alarm setpoint AND IV-FTC)
  THEN :: (RLS-EXC-1HR)

RULE132
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 1.6"
  IF    :: (PRM-10 = >3.7E3 cpm, High alarm AND BIV-FTC AND SGB-RIVER)
  THEN :: (RLS-EXC-1HR)

RULE133
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 1.7"
  IF    :: (I-131 = > Tech Spec limits AND I-131-RLS)
  THEN :: (RLS-EXC-1HR)

RULE134
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 2.1"
  IF    :: (PRM-1C = >9.9E4 cpm)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)
```

```
RULE135
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 2.5"
  IF    :: (PRM-9 = > 10 times High alarm setpoint AND IV-FTC)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE136
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 2.6"
  IF    :: (PRM-10 = >3.7E4 cpm AND BIV-FTC AND SGB-RIVER)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE137
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 2.7"
  IF    :: (I-131 = > 10 times Tech Spec limits AND I-131-RLS)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE138
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 3.1"
  IF    :: (PRM-1D = ">2.0E2 cpm for 0.5 hr (PURGE MODE)" OR PRM-1D = "
           >2.0E3 cpm for 2 minutes (PURGE MODE)" )
  THEN :: (RLS-LIMIT1-1)

RULE139
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 3.2"
  IF    :: (PRM-1D = ">7.0E4 cpm for 0.5 hr (PRESSURE RELIEF MODE)" OR
           PRM-1D = ">7.0E5 cpm for 2 minutes (PRESSURE RELIEF MODE)" )
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE140
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Steps 3.4 and 6.2"
  IF    :: (PRM-2D = "> 8.3E1 cpm for 0.5 hr" OR PRM-2D = "> 8.3E2 cpm for
           2 minutes" )
  THEN :: (RLS-LIMIT1-1 AND RLS-LIMIT1-3)

RULE141
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 4.1"
  IF    :: (ARM-15-LK = LIMIT B)
  THEN :: (RLS-EAB)

RULE142
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 5.1"
  IF    :: (ARM-15-LK = LIMIT C OR ARM-15-LK = LIMIT D)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)
```

```
RULE143
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 7.2"
  IF    :: (EAB-LMT = LIMIT E)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)

RULE144
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 7.1"
  IF    :: (RLS-LIMIT1-1 AND EAB-CALC)
  THEN :: (RLS-LIMIT2)

RULE145
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 1.2"
  IF    :: (PRM-1D = >8.0E1 cpm, High alarm (PRESSURE RELIEF MODE))
  THEN :: (RLS-EXC-1HR)

RULE146
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 1.3"
  IF    :: (PRM-2C = >4.7E3 cpm, High alarm)
  THEN :: (RLS-EXC-1HR)

RULE147
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 1.4"
  IF    :: (PRM-6B = >1.8E2 cpm, High alarm)
  THEN :: (RLS-EXC-1HR)

RULE148
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 2.2"
  IF    :: (PRM-1D = >8.0E2 cpm (PRESSURE RELIEF MODE))
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE149
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 2.3"
  IF    :: (PRM-2C = >4.7E4 cpm)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)

RULE150
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 2.4"
  IF    :: (PRM-6B = >1.8E3 cpm)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL)
```

```
RULE151
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Steps 3.3 and 6.1"
  IF    :: (PRM-1E)
  THEN :: (RLS-LIMIT1-1 AND RLS-LIMIT1-3)

RULE152
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Steps 3.5 and 6.3"
  IF    :: (PRM-6B = ">1.8E5 cpm for 0.5 hr" OR PRM-6B = "Off-scale for 2
           minutes" )
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1 AND
           RLS-LIMIT1-3 )

RULE153
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 3.6"
  IF    :: (PRM-6C)
  THEN :: (RLS-LIMIT1-1)

RULE154
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 3.7"
  IF    :: (I-131-RR)
  THEN :: (RLS-EXC-1HR AND RLS-NOT-CNTRL AND RLS-LIMIT1-1)

RULE155
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 4.2"
  IF    :: (EAB-LMT = LIMIT B)
  THEN :: (RLS-EAB)

RULE156
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 4.3"
  IF    :: (ARM22/23 = >1.0 mR/hr)
  THEN :: (RLS-EAB)

RULE157
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 4.4"
  IF    :: (EAB-I-131 = >1.0E-10 microCi/cc)
  THEN :: (RLS-EAB)

RULE158
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 5.2"
  IF    :: (EAB-LMT = LIMIT C OR EAB-LMT = LIMIT D)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)
```

```
RULE159
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 5.3"
  IF    :: (ARM22/23 = ">50 mR/hr for 0.5 hr" OR ARM22/23 = ">500 mR/hr for
            2 minutes" )
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)

RULE160
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 5.4"
  IF    :: (EAB-I-131 = ">1.0E-7 microCi/cc [>250 mrem/hr] for 0.5 hr" OR
            EAB-I-131 = ">1.0E-6 microCi/cc [>2500 mrem/hr] for 2 minutes"
            )
  THEN :: (RLS-EAB AND RLS-LIMIT1-2)

RULE161
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7.3"
  IF    :: (ARM22/23 = >1000 mR/hr)
  THEN :: (RLS-EAB AND RLS-LIMIT1-2 AND RLS-LIMIT2)

RULE162
=======
  SUBJECT :: EP-MODULE-01-RULES
  UTILITY :: -20
  COMMENT :: "Module 1 - Step 7.4"
  IF    :: (EAB-DOSE = Yes, based on actual meteorology)
  THEN :: (RLS-LIMIT1-2 AND RLS-LIMIT2)

RULE234
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 6 [Entry Point]"
  IF    :: (! RLS-LIMIT1-3)
  THEN :: (MOD1-STEP6 = No Emergency Declared)

RULE235
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7"
  IF    :: (RLS-LIMIT1-3 AND ! RLS-LIMIT2)
  THEN :: (MOD1-STEP6 = Site Area Emergency)

RULE236
=======
  SUBJECT :: EP-MODULE-01-RULES
  COMMENT :: "Module 1 - Step 7"
  IF    :: (RLS-LIMIT1-3 AND RLS-LIMIT2)
  THEN :: (MOD1-STEP6 = General Emergency)

RULE270
=======
  SUBJECT :: EP-MODULE-01-RULES
  IF    :: (EAB-DOSE = Yes, based on adverse meteorology)
  THEN :: (RLS-LIMIT1-2)
```

```
  ====================
     DATA-XFER-RULES
  ====================

RULE237
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (ED1067 < 0.1 AND ED1068 < 0.1)
  THEN :: (PRM1-MODE = Isolation Mode)

RULE238
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((ED1067 > 0.9 OR ED1068 > 0.9) AND (P1046 > 5. OR P1047 > 5.))
  THEN :: (PRM1-MODE = Pressure Relief Mode)

RULE239
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((ED1067 > 0.9 OR ED1068 > 0.9) AND (P1046 <= 5. OR P1047 <= 5.
            ) )
  THEN :: (PRM1-MODE = Purge Mode)

RULE240
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1002 IS KNOWN AND PRM1-MODE = Purge Mode)
  THEN :: (PRM-1C = (E (SELECT-ITEM (GET-LEVEL (GET-TREND R1002 ALL) (
            VAL1 FRAME MINUTE-15 ) ) (QUOTE (9900 99000)) (QUOTE ("Less
            than 9.9E3" ">9.9E3 cpm" ">9.9E4 cpm" ) ) ) ) )

RULE241
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE243 RULE242)
  IF    :: (R1003 IS KNOWN AND PRM1-MODE = Pressure Relief Mode)
  THEN :: (PRM-1D = (E (SELECT-ITEM (GET-LEVEL (GET-TREND R1003 ALL) (
            VAL1 FRAME MINUTE-15 ) ) (QUOTE (80. 800.)) (QUOTE ("Less than
            8.0E1 cpm" ">8.0E1 cpm, High alarm (PRESSURE RELIEF MODE)" "
            >8.0E2 cpm (PRESSURE RELIEF MODE)" ) ) ) ) )

RULE242
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE243)
  IF    :: (PRM1-MODE = "Pressure Relief Mode" AND (E (GET-LEVEL (
            GET-TREND R1003 ALL ) (VAL1 FRAME MINUTE-30) ) ) > 70000 )
  THEN :: (PRM-1D = >7.0E4 cpm for 0.5 hr (PRESSURE RELIEF MODE))

RULE243
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (PRM1-MODE = "Pressure Relief Mode" AND (E (GET-LEVEL (
            GET-TREND R1003 ALL ) (VAL1 FRAME MINUTE-2) ) ) > 700000 )
  THEN :: (PRM-1D = >7.0E5 cpm for 2 minutes (PRESSURE RELIEF MODE))

RULE246
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (PRM1-MODE = "Purge Mode" AND (E (GET-LEVEL (GET-TREND R1003
            ALL ) (VAL1 FRAME MINUTE-2) ) ) > 2000 )
  THEN :: (PRM-1D = >2.0E3 cpm for 2 minutes (PURGE MODE))
```

```
RULE247
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE246)
  IF    :: (PRM1-MODE = "Purge Mode" AND (E (GET-LEVEL (GET-TREND R1003
           ALL ) (VAL1 FRAME MINUTE-30) ) ) > 200 )
  THEN :: (PRM-1D = >2.0E2 cpm for 0.5 hr (PURGE MODE))

RULE248
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE247 RULE246)
  IF    :: (R1003 IS KNOWN AND PRM1-MODE = Purge Mode)
  THEN :: (PRM-1D = Less than 8.0E1 cpm)

RULE249
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1007 IS KNOWN)
  THEN :: (PRM-2C = (E (SELECT-ITEM (GET-LEVEL (GET-TREND R1007 ALL) (
           VAL1 FRAME MINUTE-15 ) ) (QUOTE (4700 47000)) (QUOTE ("Less
           than 4.7E3" ">4.7E3 cpm, High alarm" ">4.7E4 cpm" ) ) ) ) )

RULE250
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((E (GET-LEVEL (GET-TREND R1014 ALL) (VAL1 FRAME MINUTE-2))) >
           1800000 )
  THEN :: (PRM-6B = Off-scale for 2 minutes)

RULE251
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE250)
  IF    :: ((E (GET-LEVEL (GET-TREND R1014 ALL) (VAL1 FRAME MINUTE-30))) >
           180000 )
  THEN :: (PRM-6B = >1.8E5 cpm for 0.5 hr)

RULE252
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE250 RULE251)
  IF    :: (R1014 IS KNOWN)
  THEN :: (PRM-6B = (E (SELECT-ITEM (GET-LEVEL (GET-TREND R1014 ALL) (
           VAL1 FRAME MINUTE-15 ) ) (QUOTE (180. 1800.)) (QUOTE ("Less
           than 1.8E2 cpm" ">1.8E2 cpm, High alarm" ">1.8E3 cpm" ) ) ) )
           )

RULE253
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1018 IS KNOWN)
  THEN :: (PRM-9 = (E (SELECT-ITEM (GET-LEVEL (GET-TREND R1018 ALL) (VAL1
           FRAME MINUTE-15 ) ) (QUOTE (100 1000)) (QUOTE ("Less than the
           High alarm setpoint" "> High alarm setpoint" "> 10 times High
           alarm setpoint" ) ) ) ) )
```

```
RULE254
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1019 IS KNOWN)
  THEN :: (PRM-10 = (E (SELECT-ITEM (GET-LEVEL (GET-TREND R1019 ALL) (
          VAL1 FRAME MINUTE-15 ) ) (QUOTE (3700 37000)) (QUOTE ("Less
          than 3.7E3 cpm" ">3.7E3 cpm, High alarm" ">3.7E4 cpm" ) ) ) )
          )

RULE255
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (MD1073 > 0.1 OR MD1074 > 0.1 OR MD1075 > 0.1 OR MD1076 > 0.1)
  THEN :: (BIV-FTC)

RULE256
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (PRM1-MODE = "Pressure Relief Mode" AND (E (GET-LEVEL (
          GET-TREND R1004 ALL ) (VAL1 FRAME MINUTE-2) ) ) > 40 )
  THEN :: (PRM-1E)

RULE257
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE256)
  IF    :: (PRM1-MODE = "Pressure Relief Mode" AND (E (GET-LEVEL (
          GET-TREND R1004 ALL ) (VAL1 FRAME MINUTE-30) ) ) > 4 )
  THEN :: (PRM-1E)

RULE258
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE256 RULE257)
  IF    :: (R1004 IS KNOWN)
  THEN :: (! PRM-1E)

RULE259
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((E (GET-LEVEL (GET-TREND R1008 ALL) (VAL1 FRAME MINUTE-2))) >
          830 )
  THEN :: (PRM-2D = > 8.3E2 cpm for 2 minutes)

RULE260
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE259)
  IF    :: ((E (GET-LEVEL (GET-TREND R1008 ALL) (VAL1 FRAME MINUTE-30))) >
          83 )
  THEN :: (PRM-2D = > 8.3E1 cpm for 0.5 hr)

RULE261
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE259 RULE260)
  IF    :: (R1008 IS KNOWN)
  THEN :: (PRM-2D = < 8.3E1 cpm)
```

```
RULE262
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((E (GET-LEVEL (GET-TREND R1015 ALL) (VAL1 FRAME MINUTE-2))) >
            93. )
  THEN :: (PRM-6C)

RULE263
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE262)
  IF    :: ((E (GET-LEVEL (GET-TREND R1015 ALL) (VAL1 FRAME MINUTE-30))) >
            9.3 )
  THEN :: (PRM-6C)

RULE264
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE 262 RULE 263)
  IF    :: (R1015 IS KNOWN)
  THEN :: (! PRM-6C)

RULE265
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1060 > 1000. OR R1061 > 1000.)
  THEN :: (ARM22/23 = >1000 mR/hr)

RULE266
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE265)
  IF    :: ((E (GET-LEVEL (GET-TREND R1060 ALL) (VAL1 FRAME MINUTE-2))) >
            500. OR (E (GET-LEVEL (GET-TREND R1061 ALL) (VAL1 FRAME
            MINUTE-2 ) ) ) > 500. )
  THEN :: (ARM22/23 = >500 mR/hr for 2 minutes)

RULE267
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE265 RULE266)
  IF    :: ((E (GET-LEVEL (GET-TREND R1060 ALL) (VAL1 FRAME MINUTE-30))) >
            50. OR (E (GET-LEVEL (GET-TREND R1061 ALL) (VAL1 FRAME
            MINUTE-30 ) ) ) > 50. )
  THEN :: (ARM22/23 = >50 mR/hr for 0.5 hr)

RULE268
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE265 RULE266 RULE267)
  IF    :: (R1060 > 1. OR R1061 > 1.)
  THEN :: (ARM22/23 = >1.0 mR/hr)

RULE269
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE265 RULE266 RULE267 RULE268)
  IF    :: (R1060 IS KNOWN OR R1061 IS KNOWN)
  THEN :: (ARM22/23 = Less than 1.0 mR/hr)
```

```
RULE271
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1020 > 360000.)
  THEN :: (PRM-13)

RULE272
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (P1001 IS KNOWN)
  THEN :: (RCS-P = (E (SELECT-ITEM (VAL1 FRAME P1001) (QUOTE (1807. 2385.
          ) ) (QUOTE ("Less than 1807 psig" "Between 1807 and 2385 psig" "
          > 2385 psig" ) ) ) ) )

RULE273
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (CORE-TC-HI5 IS KNOWN)
  THEN :: (5-CE-TC = (E (SELECT-ITEM (VAL1 FRAME CORE-TC-HI5) (QUOTE (620
          714 1200 ) ) (QUOTE ("Less than 620 degrees F" "> 620 degrees F"
          "> 714 degrees F" "> 1200 degrees F" ) ) ) ) )

RULE274
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((T1119 IS KNOWN OR T1121 IS KNOWN OR T1123 IS KNOWN OR T1125
          IS KNOWN ) AND (E (* 0.5 (- (+ (VAL1 FRAME T1119) (VAL1 FRAME
          T1121 ) (VAL1 FRAME T1123) (VAL1 FRAME T1125) ) (MIN (VAL1
          FRAME T1119 ) (VAL1 FRAME T1121) (VAL1 FRAME T1123) (VAL1
          FRAME T1125 ) ) (MAX (VAL1 FRAME T1119) (VAL1 FRAME T1121) (
          VAL1 FRAME T1123 ) (VAL1 FRAME T1125) ) ) ) ) > 620. )
  THEN :: (RCS-T-HI)

RULE275
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: ((L1052 IS KNOWN AND L1052 < 39) OR (L1053 IS KNOWN AND L1053 <
          39 ) )
  THEN :: (RVLIS)

RULE276
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (P1046 IS KNOWN)
  THEN :: (CONT-P = (E (SELECT-ITEM (VAL1 FRAME P1046) (QUOTE (3.5 10.))
          (QUOTE ("Less than 3.5 psig" "> 3.5 psig, High alarm" "
          Approaching 60 psig" ) ) ) ) )

RULE277
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (R1023 > 100. OR R1024 > 100. OR R1025 > 100. OR R1026 > 100.)
  THEN :: (PRM-16)

RULE278
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (CONT-P = "> 3.5 psig, High alarm" OR CONT-P = "Approaching 60
          psig" OR (L1048 IS KNOWN AND L1048 > 5.) OR ARM-15 = "> 100
          R/hr, High alarm" OR CONT-HUMID )
  THEN :: (CONT-HIGH)
```

```
RULE288
=======
  SUBJECT :: DATA-XFER-RULES
  IF    :: (M1000 > 100. OR M1002 > 100. OR M1004 > 100. OR M1006 > 100.)
  THEN :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = SEVERE)

RULE289
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE288)
  IF    :: (M1000 > 90. OR M1002 > 90. OR M1004 > 90. OR M1006 > 90.)
  THEN :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = SERIOUS)

RULE290
=======
  SUBJECT :: DATA-XFER-RULES
  DOBEFORE :: (RULE288 RULE289)
  IF    :: (M1000 > 75. OR M1002 > 75. OR M1004 > 75. OR M1006 > 75.)
  THEN :: (NAT-UNUSUAL AND NAT-TYPE = High Winds AND NAT-WINDS = UNUSUAL)


  ========================
     PROMPT-CNTRL-RULES
  ========================

RULE291
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  IF    :: ((GET-TIME HEAR-FROM-USER AGE00) > ((60 * 100) * TALK-INTERVAL)
           OR (GET-TIME HEAR-FROM-USER AGE00) <= 0 )
  THEN :: (HEAR-FROM-USER AND SET-OPTIONS OFF NO-RETURN-KEY NO-PROMPT AND
           TIME-STAMP HEAR-FROM-USER AND PRINT :ATTR (QUOTE (blink red)) "
           Press [ALT] then [F8] once..." )

RULE292
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  IF    :: ((GET-TIME HEAR-FROM-USER AGE00) < ((60 * 100) * TALK-INTERVAL)
           AND (GET-TIME HEAR-FROM-USER AGE00) >= 0 )
  THEN :: (! HEAR-FROM-USER AND SET-OPTIONS ON NO-RETURN-KEY NO-PROMPT)

RULE293
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 5 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE PWR-UV PWR-UV-2 PWR-DG-LOSS PWR-OFF/AC
           PWR-ON-DC ALARM-LOSS PWR-LOSS-30 PWR-ON-DC-15 TRANSIENT
           PWR-LOSS-FW ) )

RULE294
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 1 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE ARM-15-LK EAB-CALC EAB-DOSE EAB-I-131
           EAB-LMT I-131 I-131-RLS I-131-RR IV-FTC SGB-RIVER ) )
```

```
RULE295
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 2 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE ARM-15 I-131-PC LAB-FF LKG-COOLANT
           LMT-CONT-INTEG MSIV-F-SG RCP-OP SM-ALARM ) )

RULE296
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 3 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE MSIV-F-SL RCS-T&P SG-FLOW-EXC SG-VLV-01
           ST-FLOW-INC ST-HIGH-SIS ST-PD-SIS ) )

RULE297
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 4 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE CONT-COOL CONT-HUMID CR-LIGHTS ECCS
           ECCS-FAIL IND-NOT-SEC LKG-P/S-TS LKG-UNID LKG-VER PB-LEAK
           PRV-OPEN PWR-UV-1 RCS-P-UNC RT-LOW-P ) )

RULE298
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 10 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE CR-EVAC CR-EVAC-NO-SD))

RULE299
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 11 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE FIRE FIRE-SAFETY1 FIRE-SAFETY2))

RULE300
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 12 - User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE SEC-ADV-ATTACK SEC-CONTROL1 SEC-CONTROL2
           SECURITY-ALERT ) )

RULE301
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 13 - User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE NAT-EQUAKE NAT-FLOOD NAT-TORNADO NAT-TYPE
           NAT-UNUSUAL NAT-VOLCANO ) )
```

```
RULE302
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 14 User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE EXT-EXIST EXT-SERIOUS-DMG EXT-SEVERE-DMG
           EXT-TOXIC1 EXT-TOXIC2 EXT-TOXIC3 ) )

RULE303
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Module 15 - User Input Parameters"
  IF    :: (! HEAR-FROM-USER)
  THEN :: (IMPORT (FROM-STORAGE INT-OTHER1 INT-OTHER2 INT-OTHER3
           INT-TURBINE-CP INT-TURBINE-SD ) )

RULE304
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 1 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE ARM-15-LK EAB-CALC EAB-DOSE EAB-I-131 EAB-LMT I-131
           I-131-RLS I-131-RR IV-FTC SGB-RIVER )

RULE305
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 2 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE ARM-15 I-131-PC LAB-FF LKG-COOLANT LMT-CONT-INTEG
           MSIV-F-SG RCP-OP SM-ALARM )

RULE306
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 3 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE MSIV-F-SL RCS-T&P SG-FLOW-EXC SG-VLV-O1 ST-FLOW-INC
           ST-HIGH-SIS ST-PD-SIS )

RULE307
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 4 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE CONT-COOL CONT-HUMID CR-LIGHTS ECCS ECCS-FAIL
           IND-NOT-SEC LKG-P/S-TS LKG-UNID LKG-VER PB-LEAK PRV-OPEN
           PWR-UV-1 RCS-P-UNC RT-LOW-P )

RULE308
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 5 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE PWR-UV PWR-UV-2 PWR-DG-LOSS PWR-OFF/AC PWR-ON-DC
           ALARM-LOSS PWR-LOSS-30 PWR-ON-DC-15 TRANSIENT PWR-LOSS-FW )
```

```
RULE309
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 10 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE CR-EVAC CR-EVAC-NO-SD)

RULE310
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 11 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE FIRE FIRE-SAFETY1 FIRE-SAFETY2)

RULE311
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 12 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE SEC-ADV-ATTACK SEC-CONTROL1 SEC-CONTROL2
           SECURITY-ALERT )

RULE312
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 13 User Input Parameters"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE NAT-EQUAKE NAT-FLOOD NAT-TORNADO NAT-TYPE
           NAT-UNUSUAL NAT-VOLCANO )

RULE313
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 14 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE EXT-EXIST EXT-SERIOUS-DMG EXT-SEVERE-DMG EXT-TOXIC1
           EXT-TOXIC2 EXT-TOXIC3 )

RULE314
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  COMMENT :: "Save Module 15 User Input Parameters for later use"
  IF    :: (DATA-MGMT IS KNOWN)
  THEN :: (TO-STORAGE INT-OTHER1 INT-OTHER2 INT-OTHER3 INT-TURBINE-CP
           INT-TURBINE-SD )

RULE340
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  IF    :: (HEAR-FROM-USER IS KNOWN)
  THEN :: ((RETRIEVE-SHARED-DATA EVENT1.DAT GROUP1.RD 150) AND
           READ-FROM-FILE "GROUP1" CLOCK ED1067 ED1068 F1059 F1060 F1061
           F1062 MD1073 MD1074 MD1075 MD1076 L1048 L1052 L1053 M1000
           M1002 M1004 M1006 P1001 P1046 P1047 AND TREND-PARM CLOCK 10 )
```

```
RULE341
=======
  SUBJECT :: PROMPT-CNTRL-RULES
  ANTECEDENT :: YES
  IF    :: (HEAR-FROM-USER IS KNOWN)
  THEN :: ((RETRIEVE-SHARED-DATA EVENT2.DAT GROUP2.RD 150) AND
           READ-FROM-FILE "GROUP2" R1000 R1001 R1002 R1003 R1004 R1005
           R1006 R1007 R1008 R1009 R1014 R1015 R1018 R1019 R1020 R1023
           R1024 R1025 R1026 R1038 R1039 R1040 R1041 R1042 R1043 R1044
           R1045 R1046 R1047 R1048 R1049 R1050 R1051 R1052 R1053 R1054
           R1055 R1056 R1057 R1058 R1059 R1060 R1061 T1119 T1121 T1123
           T1125 CORE-TC-HI5 AND TREND-PARM R1002 10 AND TREND-PARM R1003
           10 AND TREND-PARM R1004 10 AND TREND-PARM R1007 10 AND
           TREND-PARM R1008 10 AND TREND-PARM R1014 10 AND TREND-PARM
           R1015 10 AND TREND-PARM R1018 10 AND TREND-PARM R1019 10 AND
           TREND-PARM R1060 10 )
```

B. RT/EM-CLASS Initiation from DOS

DOS Batch File: SELECT.BAT

```
c:\greene\pclib\%1\stage %1 %2
```

DOS Batch File: STAGE.BAT

```
REM: echo off
c:
cd \greene\pclib\%1
copy %1.kb         %2\pcplus\*.*
copy %1.kbf        %2\pcplus\*.*
copy %1.k1         %2\pcplus\*.*
copy gevent1.dat   %2\pcplus\event1.dat
copy gevent2.dat   %2\pcplus\event2.dat
%2
cd \pcplus
call pc
erase %1.kb
erase %1.kbf
erase %1.k1
erase event.dat
erase event.rd
erase fec.err
```

Example of how this might be applied:

```
SELECT RT6 C:
```

File GEVENT1.DAT

```
(          0.0)
(          1.0)
(          1.0)
(        100.0)
(        100.0)
(        100.0)
(        100.0)
(          0.0)
(          0.0)
(          0.0)
(          0.0)
(          1.0)
(        100.0)
(        100.0)
(         10.0)
(         10.0)
(         10.0)
```

```
(         10.0)
(       2000.0)
(          1.2)
(          1.0)
(        556.0)
```

File GEVENT2.DAT

```
(          1.0)
(          1.0)
(        100.0)
(         10.0)
(          1.0)
(          1.0)
(          1.0)
(         50.0)
(         10.0)
(          1.0)
(        100.0)
(          1.0)
(         50.0)
(        100.0)
(     350000.0)
(         50.0)
(         50.0)
(         50.0)
(         50.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          1.0)
(          0.1)
(          0.1)
(        500.0)
(        500.0)
(        500.0)
(        500.0)
(        556.0)
```

If you want to run this program in a RAM disk, the Scheme, Personal Consultant™ Plus, and Online software must be moved there before loading the expert system. This is accomplished with the batch file

RAMSETUP.BAT

which is composed of the following commands:

```
ECHO OFF
copy  c:\command.com          d:\*.*                        >NUL

copy  c:\user\ddir.com        d:\*.*                        >NUL
copy  c:\user\n.com           d:\*.*                        >NUL

xcopy c:\pcplus\init-ol.fsl   d:\pcplus\*.*           /s >NUL
copy  c:\pcplus\init-olr.fsl  d:\pcplus\*.*              >NUL
copy  c:\pcplus\l-englsh.fsl  d:\pcplus\*.*              >NUL
copy  c:\pcplus\machine.exe   d:\pcplus\*.*              >NUL
copy  c:\pcplus\memtype.exe   d:\pcplus\*.*              >NUL
copy  c:\pcplus\pc.bat        d:\pcplus\*.*              >NUL
copy  c:\pcplus\pc-aload.fsl  d:\pcplus\*.*              >NUL
copy  c:\pcplus\pc-main.fsl   d:\pcplus\*.*              >NUL
copy  c:\pcplus\pc-supt.fsl   d:\pcplus\*.*              >NUL
copy  c:\pcplus\pcpibm.xli    d:\pcplus\*.*              >NUL
copy  c:\pcplus\pcplus.fsl    d:\pcplus\*.*              >NUL
copy  c:\pcplus\xlibm.exe     d:\pcplus\*.*              >NUL

xcopy c:\pcplus\code\browse.fsl   d:\pcplus\code\*.* /s >NUL
copy  c:\pcplus\code\changedr.fsl d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\de-input.fsl d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\de-main.fsl  d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\dosfile.fsl  d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\filelist.fsl d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\filname.fsl  d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\graphic.fsl  d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\ie-main.fsl  d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\kbl.fsl      d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\kblist.fsl   d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\kbs.fsl      d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\move.fsl     d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\multisel.fsl d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\oldpmath.fsl d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\online.fsl   d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\remrtns.fsl  d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\rules.fsl    d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\sfont.dat    d:\pcplus\code\*.*    >NUL
copy  c:\pcplus\code\translat.fsl d:\pcplus\code\*.*    >NUL

xcopy c:\pcplus\doc\decmds.doc  d:\pcplus\doc\*.*    /s >NUL
copy  c:\pcplus\doc\develop.doc d:\pcplus\doc\*.*       >NUL
```

```
xcopy c:\pcs\compiler.fsl    d:\pcs\*.*              /s >NUL
copy  c:\pcs\pcs.exe         d:\pcs\*.*                 >NUL
copy  c:\pcs\pcsexp.exe      d:\pcs\*.*                 >NUL
copy  c:\pcs\pdos.fsl        d:\pcs\*.*                 >NUL
copy  c:\pcs\pfunarg.fsl     d:\pcs\*.*                 >NUL
copy  c:\pcs\pgr.fsl         d:\pcs\*.*                 >NUL
copy  c:\pcs\pinspect.fsl    d:\pcs\*.*                 >NUL
copy  c:\pcs\pnum2s.fsl      d:\pcs\*.*                 >NUL
copy  c:\pcs\pp.fsl          d:\pcs\*.*                 >NUL
copy  c:\pcs\psort.fsl       d:\pcs\*.*                 >NUL
copy  c:\pcs\pwindows.fsl    d:\pcs\*.*                 >NUL
copy  c:\pcs\runtime.app     d:\pcs\*.*                 >NUL
```

To run the expert system in the RAM disk, the following example

```
RAMSETUP
SELECT RT6 D:
```

C. Sensor List

The list of sensor data which is to be provided by the simulator to the expert system RT/EM-CLASS is provided in Appendix T. These are the items which are expected to be immediately available from the plant process control computer. They are listed by TSC Number.

ED1067	Containment Vent Isol Tr. A	[-]
ED1068	Containment Vent Isol Tr. B	[-]
F1059	Aux Feed Flow to SG A	[lb/s]
F1060	Aux Feed Flow to SG B	[lb/s]
F1061	Aux Feed Flow to SG C	[lb/s]
F1062	Aux Feed Flow to SG D	[lb/s]
MD1073	SG A Blowdown Isolation	[-]
MD1074	SG B Blowdown Isolation	[-]
MD1075	SG C Blowdown Isolation	[-]
MD1076	SG D Blowdown Isolation	[-]
L1048	Containment sump level - Wide (A)	[ft]
L1052	RVLIS - Full Range Tr. A	[%]
L1053	RVLIS - Full Range Tr. B	[%]
M1000	Wind Speed - El. 33 ft (A)	[mph]
M1002	Wind Speed - El. 33 ft (B)	[mph]
M1004	Wind Speed - El. 200 ft	[mph]
M1006	Wind Speed - El. 500 ft	[mph]
P1001	RCS pressure - wide range	[psig]
P1046	Containment pressure - wide range #1	[psig]
P1047	Containment pressure - wide range #2	[psig]
R1002	PRM-1C: Containment vent low noble gas	[cpm]
R1003	PRM-1D: Containment vent high noble gas	[cpm]
R1004	PRM-1E: Containment vent hi-hi noble gas	[mR/h]
R1007	PRM-2C: Aux bldg vent low noble gas	[cpm]
R1008	PRM-2D: Aux bldg vent high noble gas	[cpm]
R1014	PRM-6B: Air ejector high noble gas	[cpm]
R1015	PRM-6C: Air ejector hi-hi noble gas	[mR/h]
R1018	PRM-9: Liquid Rad-waste discharge	[???]
R1019	PRM-10: Steam generator blowdown	[cpm]
R1020	PRM-13: Gross failed fuel	[cpm]

R1023	PRM-16A: Main Steam Line A	[mR/h]
R1024	PRM-16B: Main Steam Line B	[mR/h]
R1025	PRM-16C: Main Steam Line C	[mR/h]
R1026	PRM-16D: Main Steam Line D	[mR/h]
R1038	ARM-1: Aux Bldg, El. 5'	[R/h]
R1039	ARM-2: Aux Bldg, El. 25'	[R/h]
R1040	ARM-3: Aux Bldg, El. 45'	[R/h]
R1041	ARM-4: Aux Bldg, El. 45'	[R/h]
R1042	ARM-5: Spent Fuel Pool, El. 45'	[R/h]
R1043	ARM-6: Cont Incore, El. 61'	[R/h]
R1044	ARM-7: Aux Bldg, El. 61'	[R/h]
R1045	ARM-8: Fuel Bldg, El. 61'	[R/h]
R1046	ARM-9: Aux Bldg Radwaste, El. 77'	[R/h]
R1047	ARM-10: Waste Conc. Tank, El. 77'	[R/h]
R1048	ARM-11: Control Room, El. 93'	[mR/h]
R1049	ARM-12: Aux Bldg Machine Shop, El. 93'	[R/h]
R1050	ARM-13: New Fuel Area, El. 93'	[R/h]
R1051	ARM-14: Aux Bldg Radwaste, El. 93'	[R/h]
R1054	ARM-16: Aux Bldg RHR, El. 5'	[R/h]
R1055	ARM-17: Aux Bldg RHR, El. 5'	[R/h]
R1056	ARM-18: Aux Bldg Vol Cnt Fac, El. 61'	[R/h]
R1057	ARM-19: Aux Bldg Facade, El. 65'	[R/h]
R1058	ARM-20: Cont Manip Crane, El. 93'	[R/h]
R1059	ARM-21: Cont Incore, El. 45'	[R/h]
R1060	ARM-22: Site boundary North	[mR/h]
R1061	ARM-23: Site boundary South	[mR/h]
T1119	RC Loop A Tavg	[F]
T1121	RC Loop B Tavg	[F]
T1123	RC Loop C Tavg	[F]
T1125	RC Loop D Tavg	[F]
T1000	In-Core Temperature A08	[F]
T1001	In-Core Temperature B03	[F]
T1002	In-Core Temperature B10	[F]
T1003	In-Core Temperature C08	[F]
T1004	In-Core Temperature C13	[F]
T1005	In-Core Temperature D03	[F]
T1006	In-Core Temperature E04	[F]
T1008	In-Core Temperature E08	[F]
T1009	In-Core Temperature E10	[F]
T1010	In-Core Temperature F12	[F]
T1011	In-Core Temperature F15	[F]
T1012	In-Core Temperature G02	[F]

T1013	In-Core Temperature G09	[F]
T1014	In-Core Temperature G11	[F]
T1015	In-Core Temperature H01	[F]
T1016	In-Core Temperature H03	[F]
T1017	In-Core Temperature H08	[F]
T1018	In-Core Temperature H13	[F]
T1019	In-Core Temperature J10	[F]
T1020	In-Core Temperature K03	[F]
T1021	In-Core Temperature K05	[F]
T1022	In-Core Temperature K15	[F]
T1023	In-Core Temperature L01	[F]
T1024	In-Core Temperature L08	[F]
T1025	In-Core Temperature L12	[F]
T1026	In-Core Temperature M10	[F]
T1027	In-Core Temperature M13	[F]
T1028	In-Core Temperature N03	[F]
T1029	In-Core Temperature N09	[F]
T1030	In-Core Temperature P05	[F]
T1031	In-Core Temperature P11	[F]
T1032	In-Core Temperature R08	[F]
T1033	In-Core Temperature A09	[F]
T1034	In-Core Temperature A11	[F]
T1035	In-Core Temperature B05	[F]
T1036	In-Core Temperature C03	[F]
T1037	In-Core Temperature C12	[F]
T1038	In-Core Temper!ture D07	[F]
T1039	In-Core Temperature D09	[F]
T1040	In-Core Temperature E02	[F]
T1041	In-Core Temperature E14	[F]
T1042	In-Core Temperature F05	[F]
T1043	In-Core Temperature F09	[F]
T1044	In-Core Temperature F11	[F]
T1045	In-Core Temperature G04	[F]
T1046	In-Core Temperature G08	[F]
T1047	In-Core Temperature H05	[F]
T1048	In-Core Temperature H09	[F]
T1049	In-Core Temperature H11	[F]
T1050	In-Core Temperature H14	[F]
T1051	In-Core Temperature J07	[F]
T1052	In-Core Temperature K11	[F]
T1053	In-Core Temperature K13	[F]
T1054	In-Core Temperature L02	[F]

T1055	In-Core Temperature L09	[F]
T1056	In-Core Temperature L14	[F]
T1057	In-Core Temperature M05	[F]
T1058	In-Core Temperature M12	[F]
T1059	In-Core Temperature N02	[F]
T1061	In-Core Temperature N13	[F]
T1062	In-Core Temperature P07	[F]
T1063	In-Core Temperature R05	[F]
T1064	In-Core Temperature R10	[F]

D. Reaching Out From Personal Consultant™ Plus

An important step in automating the task of classification is developing the means for getting the electronically transferred information into the expert system in a usable form. There are several options available.

Methods Suggested by Texas Instruments

The RT/EM-CLASS application is developed with Personal Consultant™ Plus, an expert system shell developed and marketed by Texas Instruments, Inc. They have developed an overlay called Online that enhances the Personal Consultant™ Plus package with features necessary to perform process monitoring and control.

The "Online" manual describes six ways to retrieve data from the outside world (the DOS environment) for use in the consulting session. They are:

- METHOD
- dBASE®
- IMPORT
- DOS-FILE-IN
- READ-FROM-FILE
- LOTUS™-WKS

Clearly, the ones which provide interface with the dBASE® and LOTUS™-WKS are specialized and not much use in our application. DOS-FILE-IN and READ-FROM-FILE are generally useful if another program, running at the same time (Multi-tasking), is updating the file periodically. The IMPORT function requires an "adapter function" that uses the scheme XCALL function to invoke a user-written device driver to retrieve the needed data. This might be appropriate when the computer that the software resides on is directly connected to the instrumentation through data acquisition hardware. This approach requires some low level machine language programming (generally assembly) to implement.

To incorporate ONLINE features into the EM-CLASS application, it will be necessary to set up a "prototyping" system consisting of an Compaq 386, the RS-232 port, and some device (such as an IBM PC-AT) to act as the plant process control computer. Through use of a small sample knowledge base and a

simulation procedure on the second computer, it will be possible to determine the necessary knowledge base structure, environment, and functions necessary to design a working application.

Adopted Methods

To provide the greatest flexibility on interface design and modification of the software, the best means for getting information into the EM-CLASS application is through the function READ-FROM-FILE. The programmer need only provide a list of parameters that are to be read from the file in the order they appear in the file to use this function. The choice of this method will require the use of some form of multi-tasking in order to decouple the data acquisition process from the EM-CLASS process and to maintain a reasonable level of efficiency and flexibility in the software.

Example of Retrieving Data From a DOS file

This appendix explains how to reach out from Personal Consultant™ Plus is to locate and retrieve data from a DOS file. The file will contain the values for two parameters used in module 3, I-131-PC and PCT-TP. They are placed in a file called "EVENT.RD" in the Personal Consultant™ Plus subdirectory. Then a rule is added to the rule group GENERAL-RULES stating the following:

ARL Form:

```
IF:: NOTIFY   IS KNOWN
THEN::READ-FROM-FILE "event" I-131-PC PCT-TP
ANTECEDENT::YES
```

English Translation:

```
If provide notification of class increase is known,
Then read data from the file event
```

This action successfully eliminates the need for the Knowledge Based System to prompt the user for the values of these two variables. One disadvantage of specifying this method of

retrieving the data (antecedent or forward chaining rule) is that antecedent rules tax the computational speed of the Knowledge Based System since the rule is tested each time the value of any parameter is set or changed. [Nearly all of the time consuming delays in the EM-CLASS Knowledge Based System application are directly attributable to checking antecedent rules.]

Example of Executing a DOS Procedure

This appendix explains how to execute a DOS application that writes the values of the two parameters, I-131-PC and PCT-TP to a data file. The Knowledge Based System first calls the program to create the data file and then reads the data from the file. This task is achieved from within Personal Consultant™ Plus with the following rule:

ARL Form:

```
IF::NOTIFY   IS KNOWN
THEN::PRINT "Retrieving Sensor Data ... " AND DOS-CALL
          "pccsimul.exe" AND READ-FROM-FILE "event"
          I-131-PC  PCT-TP
ANTECEDENT::YES
```

English Translation:

```
If provide notification of class increase is known,
Then,
     1) inform the user of this decision, and
     2) call a DOS program named pccsimul.exe, and
     3) read data from the file event
```

The message about retrieving data is provided to give the Knowledge Based System user an idea of what is going on when the screen starts flashing. With this rule it is possible to write simulators or drivers which can simulate scenarios in which to test the program. One could even conceive of writing scenarios which would allow automatic verification of the functionality of the program but such a course of action is not being considered at the moment.

E. DOS Multi-tasking Software Review

Two utilities were considered for multi-tasking software managers in the DOS environment. They are PC-Mix (Proware) and Desqview (Quarterdeck).

The utility PC-MIX provides multi-tasking capability. The successful implementation of this utility eliminates the need to worry about assembly and machine level coding to handle the interrupts which might be associated with receiving data transmissions at arbitrary times. Up to three independent processes may be executing on a DOS machine at the same time. The CPU time is divided between the applications based on the priority (from 1 to 3) assigned to the process.

Some care must be exercised when using PC-MIX for best results. Most large DOS applications are able to use code larger than 640K by uploading optional code segments from the hard disk on demand. They do however require a certain minimum amount of RAM for the main program or essential code to reside in. When executing applications under PC-MIX, the essential code for all processes must fit within the 640K internal DOS memory limit. The rest of the code (those parts loaded on demand by the application) may reside in virtually unlimited RAM in the form of EEMS (Expanded memory) during execution.

If enough memory is not allocated to an application, an out of memory error may occur. This is not fixable without stopping all processes and exiting PC-MIX. The CFG.EXE program must then be used to alter the configuration.

PC-MIX does not properly access extended memory as it is used by the Personal Consultant™ Plus/Online package. The symptoms of the problem include substantially lengthened (10-20 times or more) computation time to reach a conclusion which happens to be incorrect. This problem was easily overcome by configuring Personal Consultant™ Plus to make use of expanded memory.

One significant factor for our application is how much overhead CPU time is taken by PC-Mix. A benchmark was

performed using EM-CLASS version 3 which exercises both CPU and the hard disk. Time trials were performed for this application when run by itself and when run as the only active process under PC-MIX. The result was that 6.66 sec/minute of CPU time was spent on overhead. This probably varies depending on what application is run and how much primary RAM is assigned to the task. Other tests with unrelated software showed less overhead devoted to PC-MIX, on the order of 1-2%.

PC-MIX exhibited a high frequency of system crashes and hanging up, especially when used with Cross-Talk, the communications package. In addition, PC-MIX is limited to a maximum of three processes. None of these three processes may be viewed simultaneously with any of the others and a minimum of two keystrokes are necessary to switch processes. Finally, there is no macro capability which could provide the ability to automatically switch between processes. This is not sufficiently flexible to provide good ergonomic display design.

Desqview was adopted as the multitasking system manager because it is stable (in 11 months of use, the system has crashed less than 4 times). It features windowing capability and keystroke macros to aid in management of multiple processes. Desqview is not limited to 3 applications open at any one time. The practical limit is RAM available. Desqview requires a 386 machine to be most effective.

Avoiding File Sharing Faults

When the system shown in Figure 1 is operated, it is probable that a problem will eventually occur because more than one process attempts to access the same file at the same time. It is not desirable to have the software fault because a file is busy. A couple different solutions to the problem are possible. They are

- Put all applications on a schedule and provide access only at predetermined times.

- Have applications "wait" until the file is available

Putting all file accesses on a wall clock schedule is a less desirable solution because it is too easy for the applications to

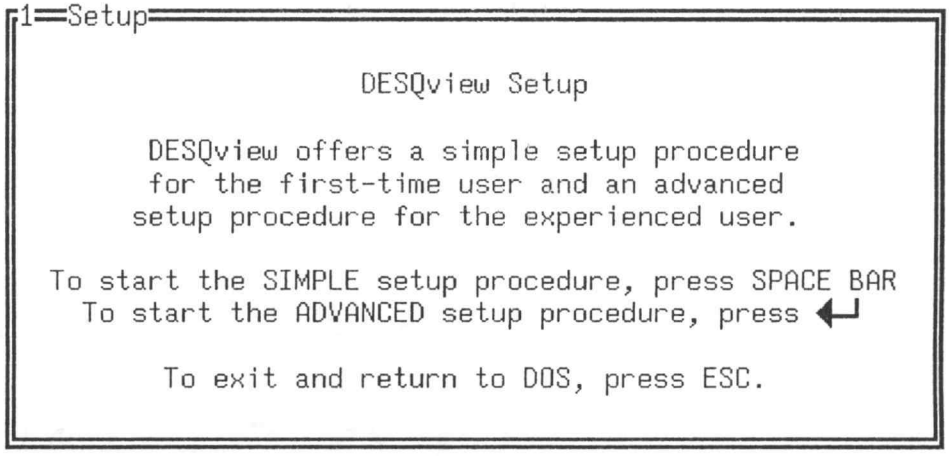
get out of synchronization during unusual circumstances. This can occur because some of the programs do not execute in a time that may be determined prior to executing the application. The solution to the problem is to program the ability to recognize that a file is busy and wait for it to become available. For FORTRAN applications, the status of an attempt to attach a file is trapped. It is a simple matter to formulate a loop that repeats the attempt to access the file. For Scheme (the language of Personal Consultant™ Plus) the following function is offered for retrieving data from a shared file:

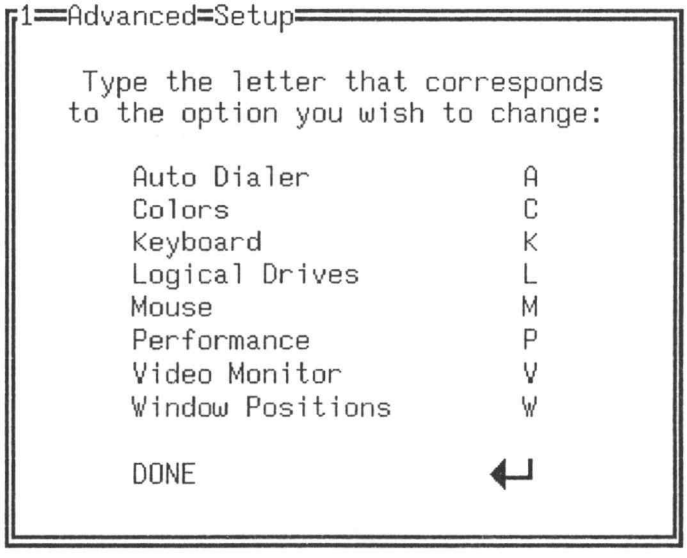
```
(DEFINE retrieve-shared-data
   (LAMBDA (source destination count)
     (COND ((<= count 0) nil)
           (ELSE
           (IF
                (DOS-FILE-COPY source destination)
                     #T
                (retrieve-shared-data source destination
                     (-1+ count)))))))
```

This is a tail recursive function that attempts to access the shared file 'count' times before faulting. When the shared file is properly attached, it is copied to the 'destination' for internal use by the EM-CLASS application.

Desqview Configuration for RT/EM-CLASS

The following pages present the Desqview setup configurations associated with the various RT/EM-CLASS processes.


1=Setup
DESQview Setup
DESQview offers a simple setup procedure
for the first-time user and an advanced
setup procedure for the experienced user.
To start the SIMPLE setup procedure, press SPACE BAR
To start the ADVANCED setup procedure, press ↵
To exit and return to DOS, press ESC.


1=Advanced=Setup
Type the letter that corresponds
to the option you wish to change:
Auto Dialer A
Colors C
Keyboard K
Logical Drives L
Mouse M
Performance P
Video Monitor V
Window Positions W
DONE ↵

```
1=Advanced=Setup:=Auto=Dialer

  Dialer Port: 1          Dialer Baud Rate: 1
       Port 1  1               Leave As Is  0
       Port 2  2                  300 Baud  1
                                  600 Baud  2
                                 1200 Baud  3
                                 2400 Baud  4
                                 4800 Baud  5
                                 9600 Baud  6

          Long Distance Access Codes
    Access Name        Phone Number & Code
  Access Code 1     1
  Access Code 2     1
  Access Code 3     1

        Change dialer protocol? (Y/N): N

                Next field     Tab
                Backup menu    Esc
                DONE           ↵
```

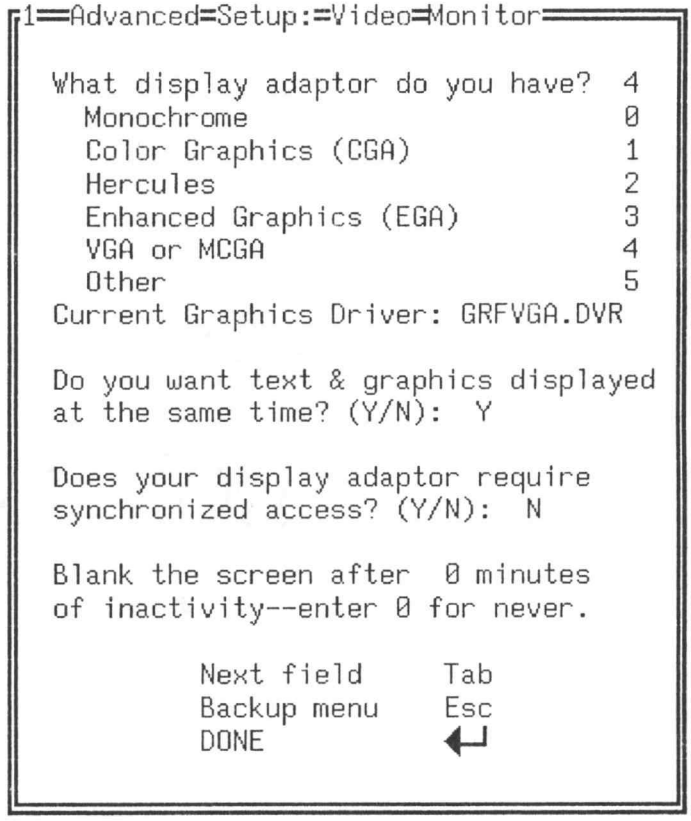
```
1=Advanced=Setup:=Colors
        Do you want DESQview to use color? Y

    Color Key:  -0- -1- -2- -3- -4- -5- -6- -7-
  Window Colors:   Text  Background Highlit?
       Window 1:      1         3         N     Sample
       Window 2:      1         6         N     Sample
       Window 3:      7         4         N     Sample
       Window 4:      1         2         N     Sample
          Menus:      7         1         N     Sample

       Colors for DESQview-Specific Programs
      Normal Text:    1         7         N     Sample
    Highlit Normal:   1         3         N     Sample
         Help Text:   0         2         N     Sample
       Highlit Help:  2         1         N     Sample
        Error Text:   7         4         Y     Sample
     Highlit Error:   0         5         N     Sample
Emphasized Normal:    0         7         N     Sample
       Marked Text:   0         6         N     Sample

                  Next field     Tab
                  Backup menu    Esc
                  DONE           ↵
```

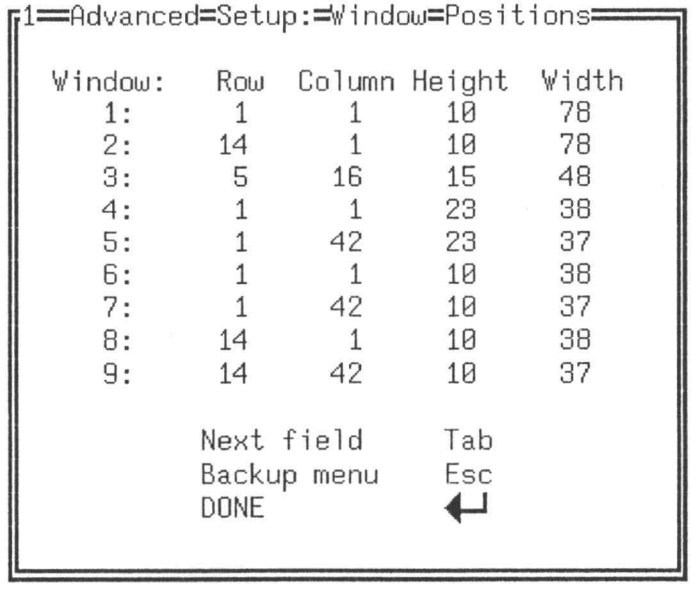
```
1=Advanced=Setup:=Keyboard

    Do you want to use DESQview's
    Learn feature? (Y/N): Y

    Quoting Char for Learn: `

    Memory Usage (in bytes)
        DESQview Scripts:  1024
        Learn Scripts:     1024
        Playback Scripts:  1024

    Change system keys? (Y/N): N

          Next field     Tab
          Backup menu    Esc
          DONE           ↵
```

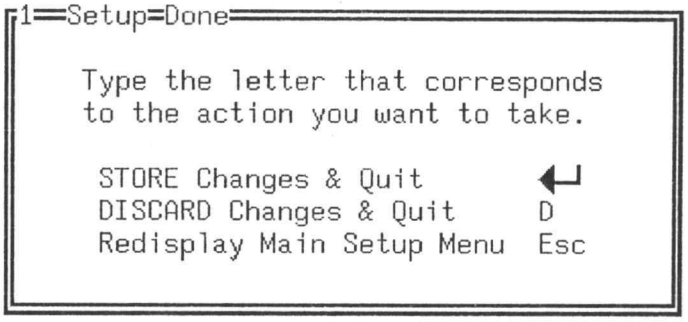
```
1=Advanced=Setup:=Logical=Drives

     A:
     B:
     C:
     D:
     E:
     F:
     G:
     H:
     I:
     J:
     K:
     L:
     M:
     N:
     O:
     P:
  SWAP:

          Next field     Tab
          Backup menu    Esc
          DONE           ↵
```

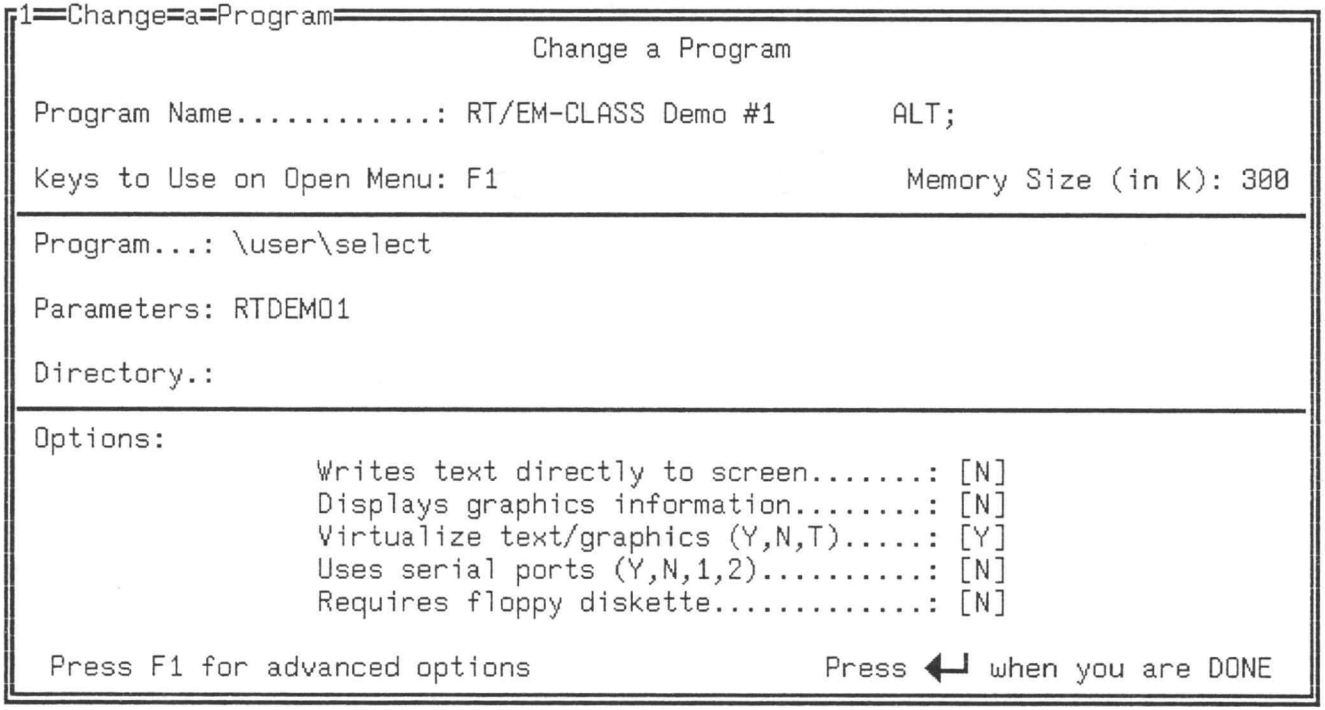
```
1=Advanced=Setup:=Mouse

Mouse Type: 0
  Keyboard                          0
  PC Mouse                          1
  Microsoft or compatible driver    2
    (IBM, PC Mouse, AT&T, Maynard,
     Logimouse, etc.)
  Logitech (w/o MS driver)          3
  VisiOn Mouse                      4

Mouse Port: 0
  Add-On Board    0
  Port 1          1
  Port 2          2

Left-handed mouse? (Y/N): N

          Next field     Tab
          Backup menu    Esc
          DONE           ↵
```

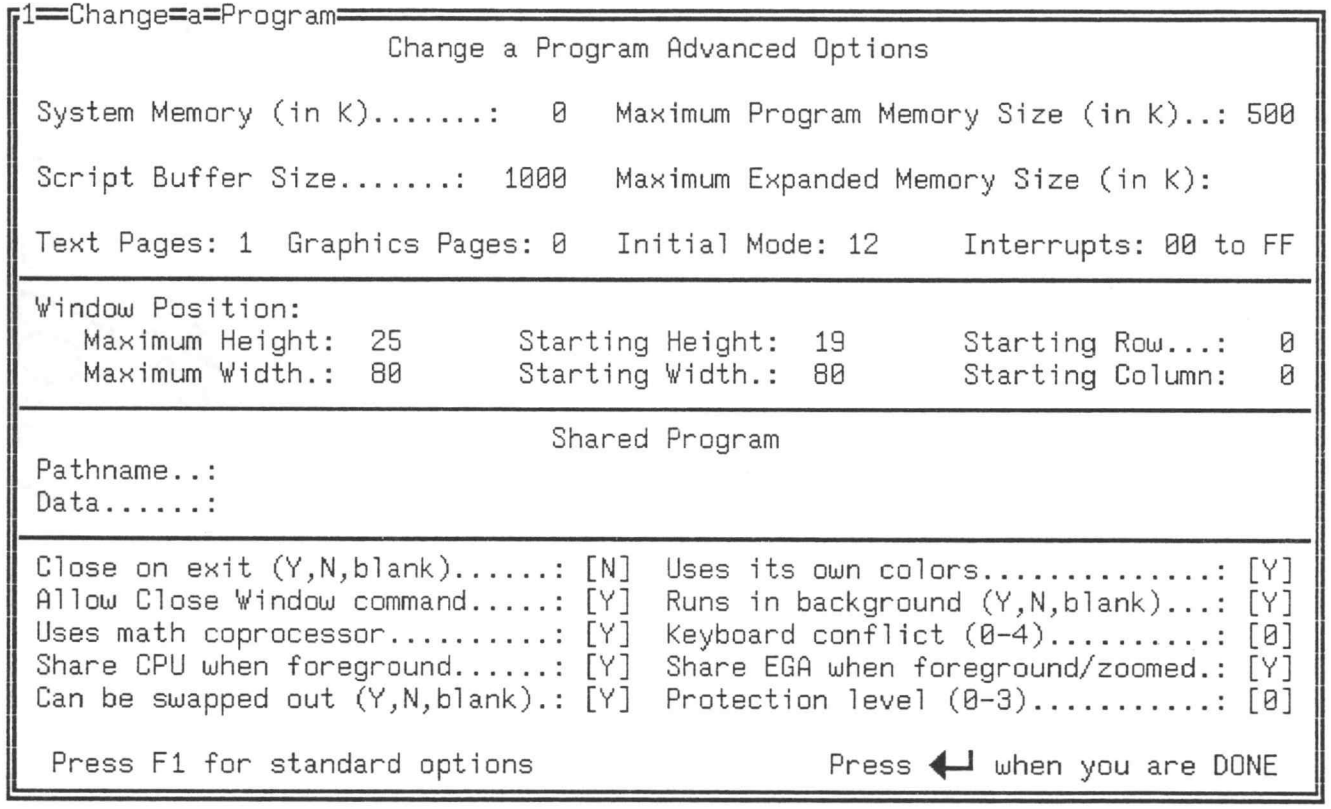
```
1=Advanced=Setup:=Performance

Task Processing Time (in Clock Ticks)
          Foreground:    9
          Background:    3

Memory Usage (in K)
    Common Memory:      17
    DOS Buffer for EMS:  2

Optimize communications?     (Y/N): Y
Allow swapping of programs?  (Y/N): Y
Manage printer contention?   (Y/N): N

          Next field     Tab
          Backup menu    Esc
          DONE           ↵
```

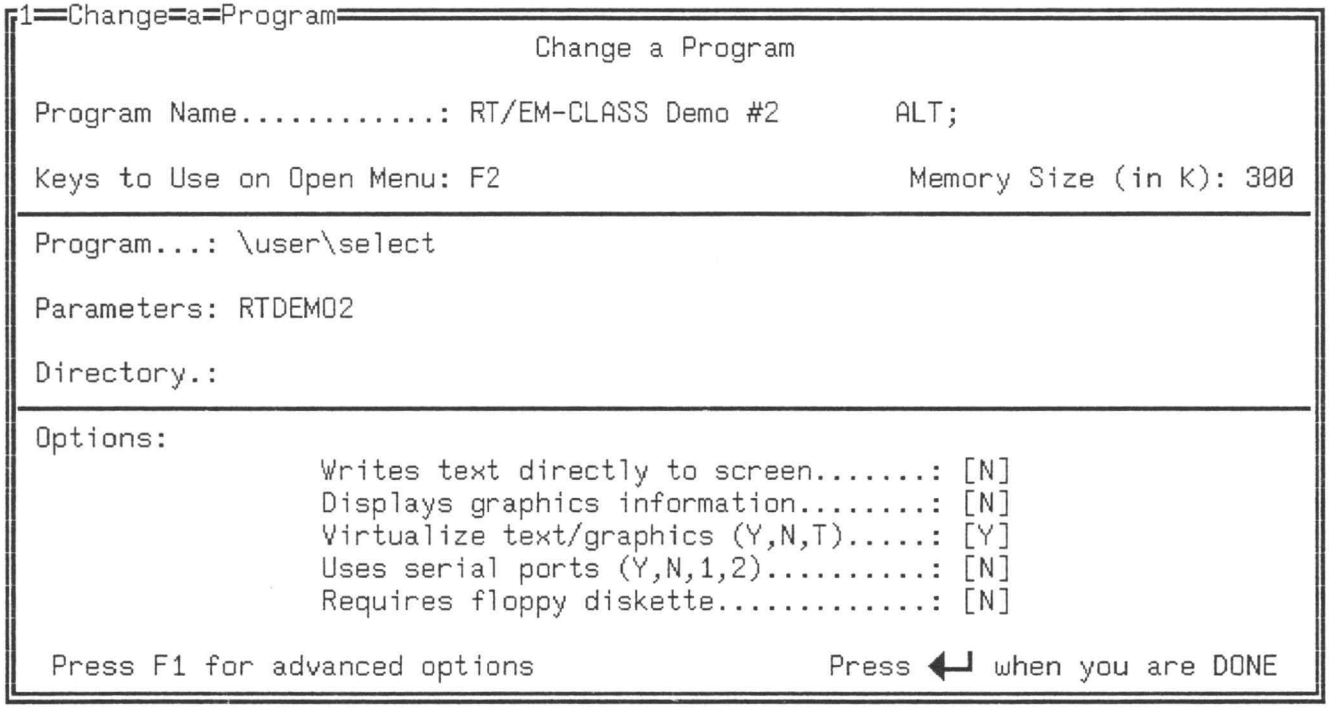

1=Advanced=Setup:=Video=Monitor
What display adaptor do you have? 4
Monochrome 0
Color Graphics (CGA) 1
Hercules 2
Enhanced Graphics (EGA) 3
VGA or MCGA 4
Other 5
Current Graphics Driver: GRFVGA.DVR
Do you want text & graphics displayed at the same time? (Y/N): Y
Does your display adaptor require synchronized access? (Y/N): N
Blank the screen after 0 minutes of inactivity--enter 0 for never.
Next field Tab
Backup menu Esc
DONE

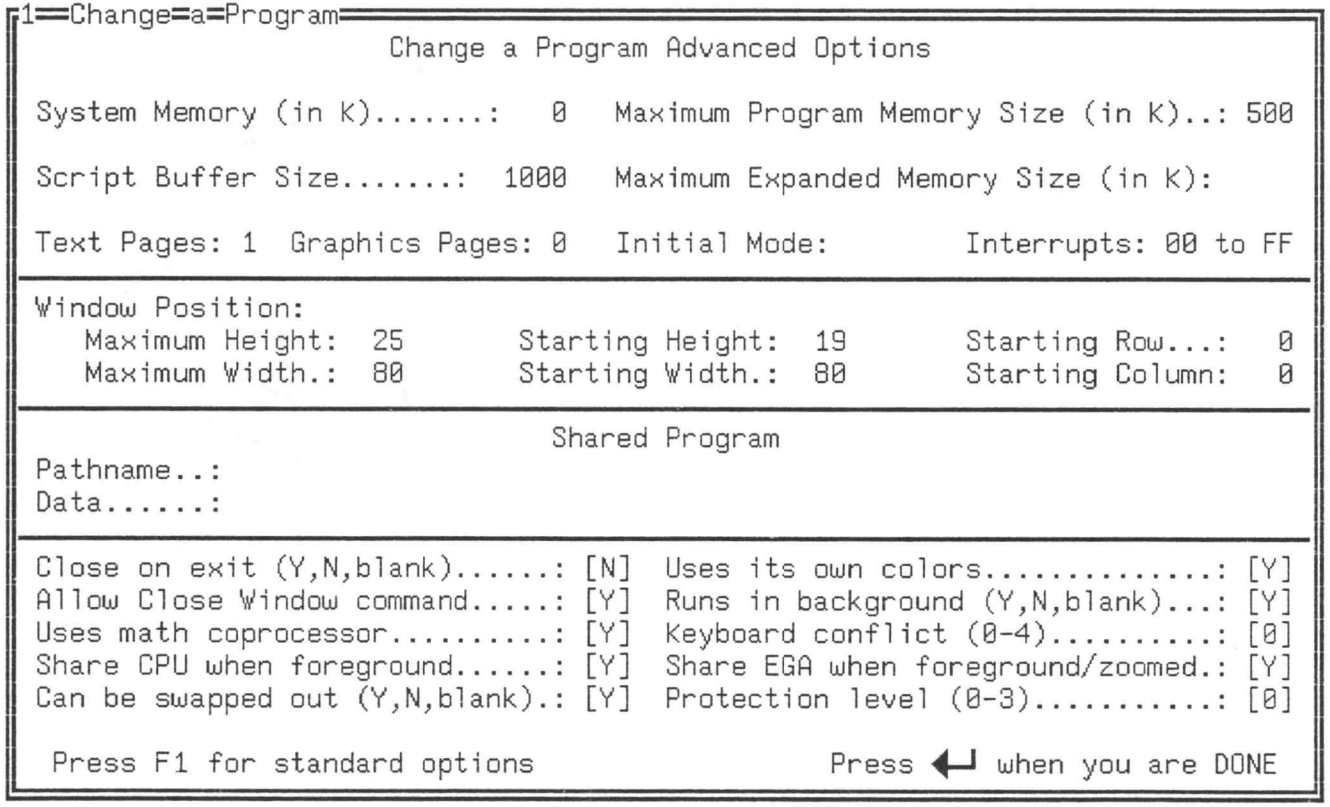

1=Advanced=Setup:=Window=Positions
Window: Row Column Height Width
1: 1 1 10 78
2: 14 1 10 78
3: 5 16 15 48
4: 1 1 23 38
5: 1 42 23 37
6: 1 1 10 38
7: 1 42 10 37
8: 14 1 10 38
9: 14 42 10 37
Next field Tab
Backup menu Esc
DONE

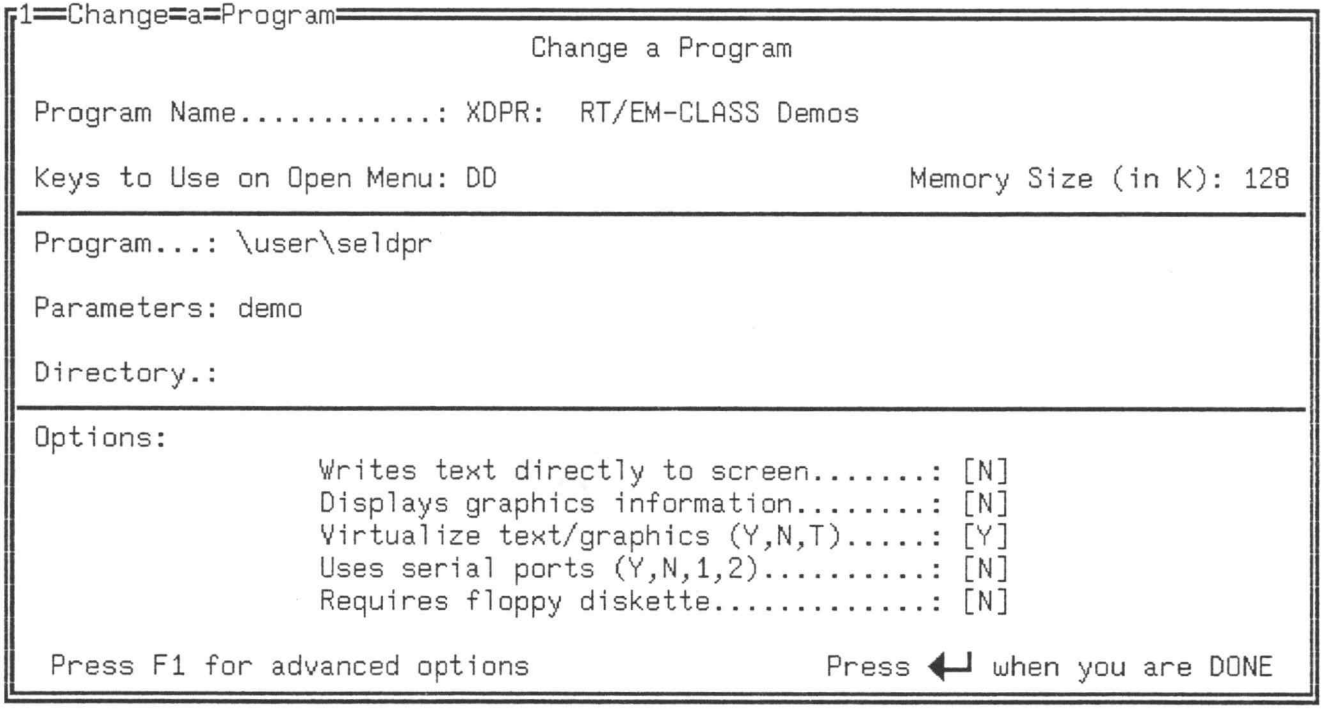

1=Setup=Done
Type the letter that corresponds
to the action you want to take.
STORE Changes & Quit ↵
DISCARD Changes & Quit D
Redisplay Main Setup Menu Esc

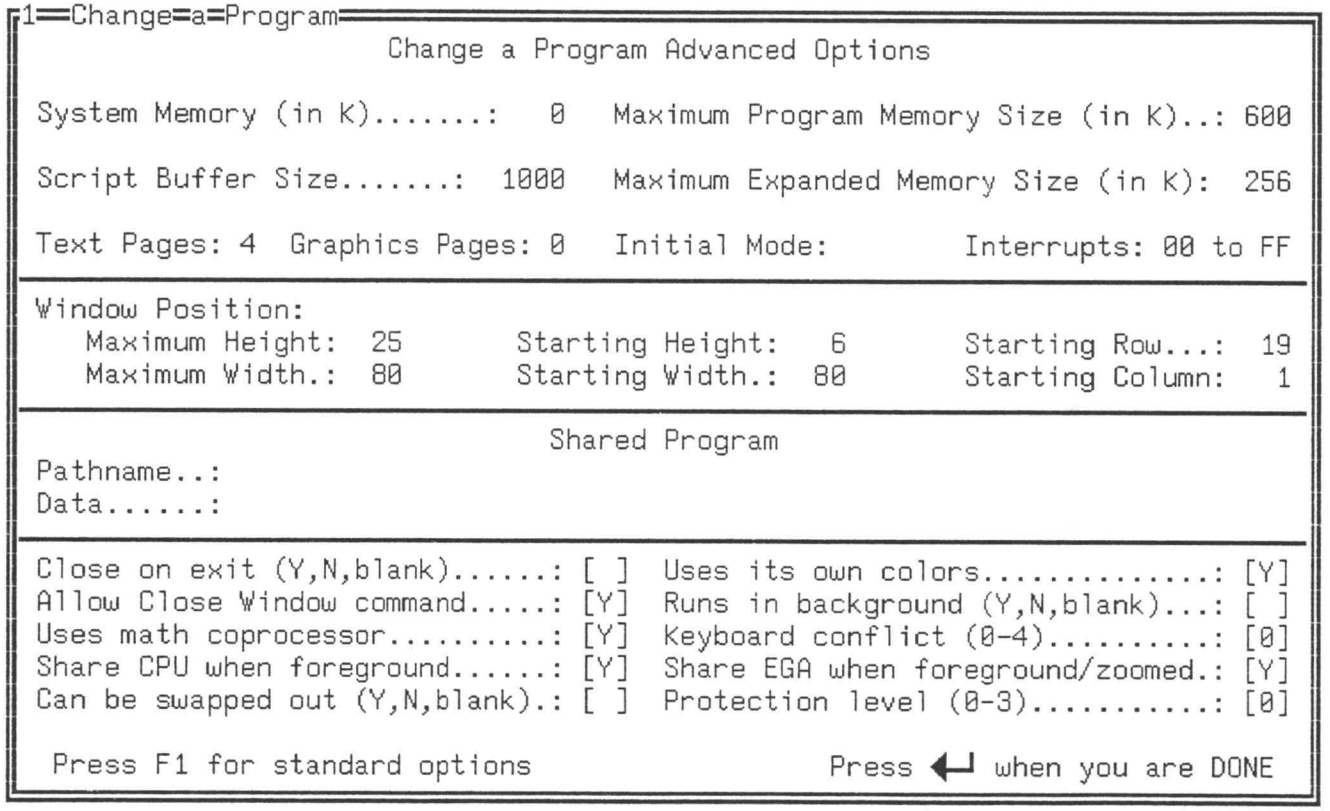

1=Change=a=Program
Change a Program
Program Name.....: RT/EM-CLASS Demo #1 ALT;
Keys to Use on Open Menu: F1
Memory Size (in K): 300
Program...: \user\select
Parameters: RTDEMO1
Directory.:
Options:
Writes text directly to screen.....: [N]
Displays graphics information.....: [N]
Virtualize text/graphics (Y,N,T).....: [Y]
Uses serial ports (Y,N,1,2).....: [N]
Requires floppy diskette.....: [N]
Press F1 for advanced options
Press ↵ when you are DONE

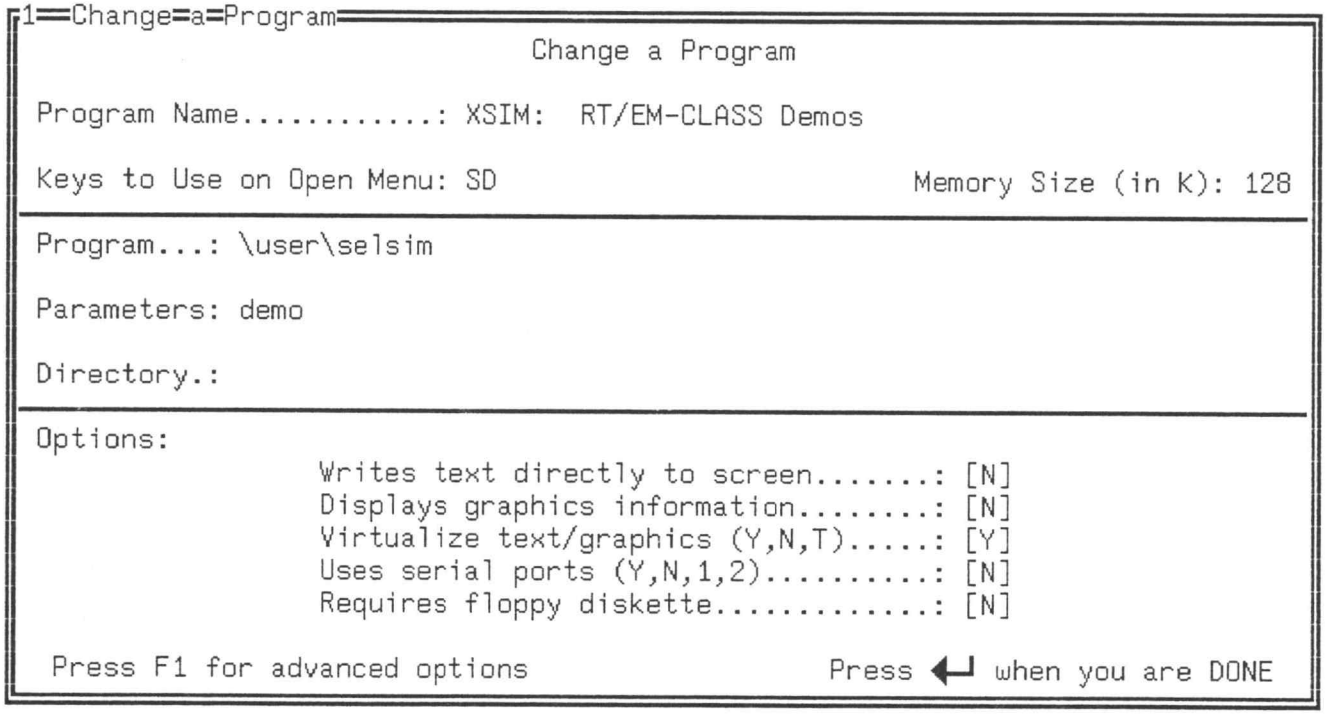

1=Change=a=Program
Change a Program Advanced Options
System Memory (in K).....: 0
Maximum Program Memory Size (in K)..: 500
Script Buffer Size.....: 1000
Maximum Expanded Memory Size (in K):
Text Pages: 1 Graphics Pages: 0
Initial Mode: 12
Interrupts: 00 to FF
Window Position:
Maximum Height: 25
Starting Height: 19
Starting Row...: 0
Maximum Width.: 80
Starting Width.: 80
Starting Column: 0
Shared Program
Pathname..:
Data.....:
Close on exit (Y,N,blank).....: [N]
Uses its own colors.....: [Y]
Allow Close Window command.....: [Y]
Runs in background (Y,N,blank)...: [Y]
Uses math coprocessor.....: [Y]
Keyboard conflict (0-4).....: [0]
Share CPU when foreground.....: [Y]
Share EGA when foreground/zoomed.: [Y]
Can be swapped out (Y,N,blank).: [Y]
Protection level (0-3).....: [0]
Press F1 for standard options
Press ↵ when you are DONE

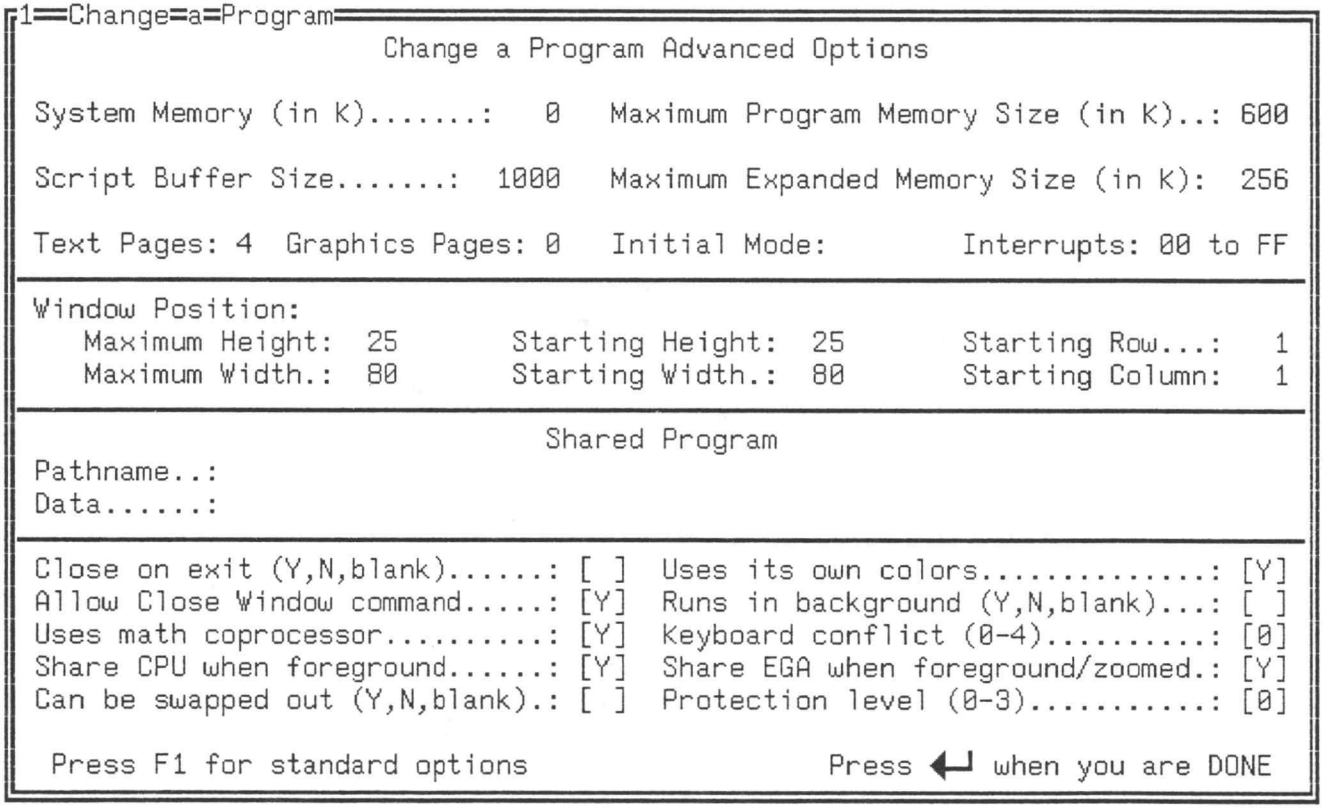

1=Change=a=Program
Change a Program
Program Name.....: RT/EM-CLASS Demo #2 ALT;
Keys to Use on Open Menu: F2
Memory Size (in K): 300
Program...: \user\select
Parameters: RTDEMO2
Directory.:
Options:
Writes text directly to screen.....: [N]
Displays graphics information.....: [N]
Virtualize text/graphics (Y,N,T).....: [Y]
Uses serial ports (Y,N,1,2).....: [N]
Requires floppy diskette.....: [N]
Press F1 for advanced options
Press ↵ when you are DONE

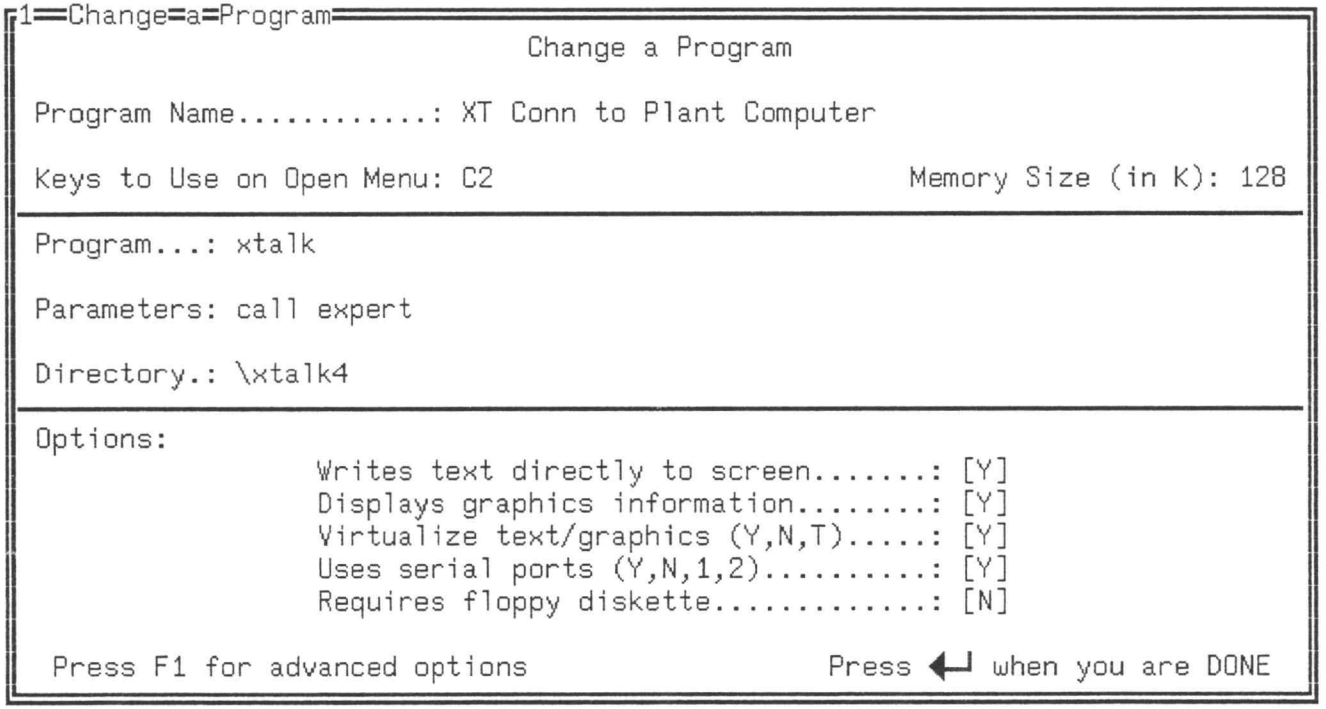

1=Change=a=Program
Change a Program Advanced Options
System Memory (in K).....: 0
Maximum Program Memory Size (in K)..: 500
Script Buffer Size.....: 1000
Maximum Expanded Memory Size (in K):
Text Pages: 1 Graphics Pages: 0
Initial Mode:
Interrupts: 00 to FF
Window Position:
Maximum Height: 25
Starting Height: 19
Starting Row...: 0
Maximum Width.: 80
Starting Width.: 80
Starting Column: 0
Shared Program
Pathname..:
Data.....:
Close on exit (Y,N,blank).....: [N]
Uses its own colors.....: [Y]
Allow Close Window command.....: [Y]
Runs in background (Y,N,blank)...: [Y]
Uses math coprocessor.....: [Y]
Keyboard conflict (0-4).....: [0]
Share CPU when foreground.....: [Y]
Share EGA when foreground/zoomed.: [Y]
Can be swapped out (Y,N,blank).: [Y]
Protection level (0-3).....: [0]
Press F1 for standard options
Press ↵ when you are DONE

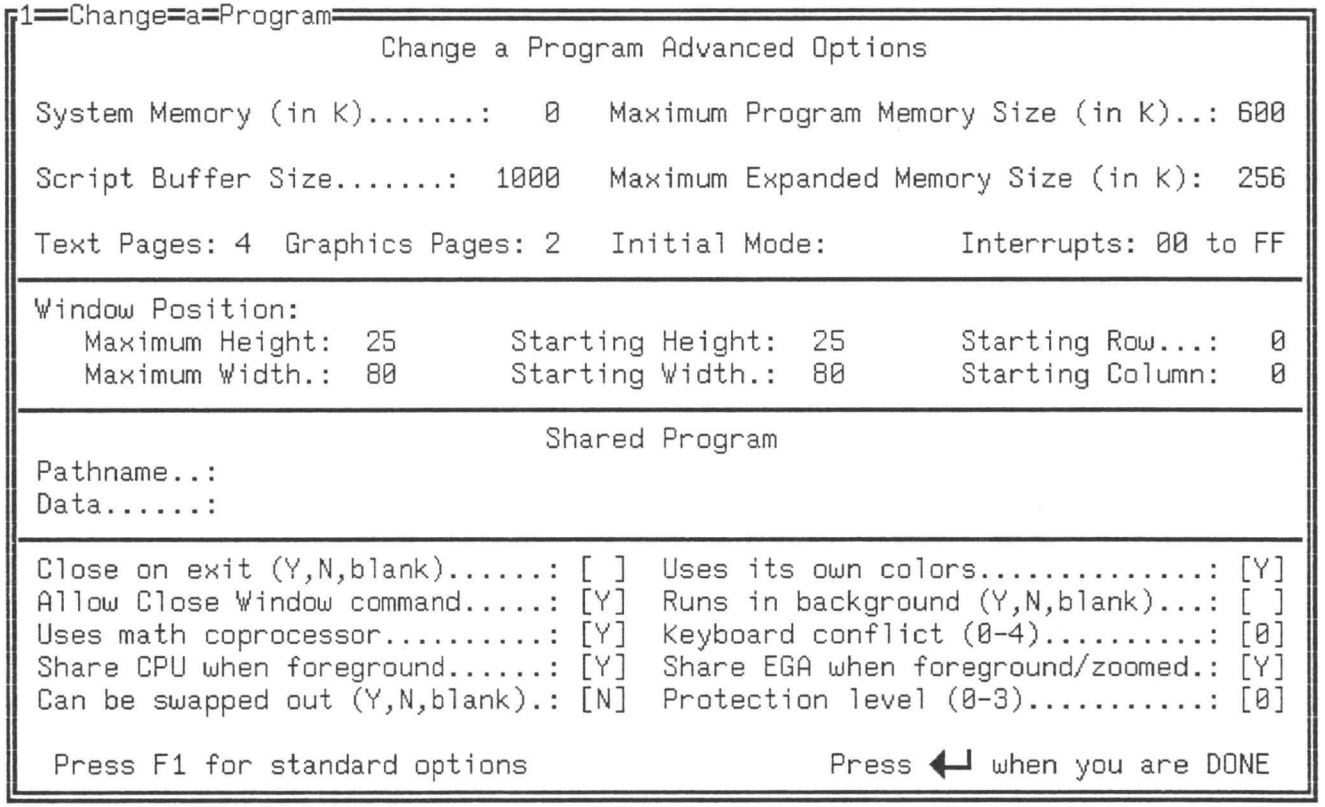

1=Change=a=Program
Change a Program
Program Name.....: XDPR: RT/EM-CLASS Demos
Keys to Use on Open Menu: DD
Memory Size (in K): 128
Program...: \user\seldpr
Parameters: demo
Directory.:
Options:
Writes text directly to screen.....: [N]
Displays graphics information.....: [N]
Virtualize text/graphics (Y,N,T).....: [Y]
Uses serial ports (Y,N,1,2).....: [N]
Requires floppy diskette.....: [N]
Press F1 for advanced options
Press ↵ when you are DONE

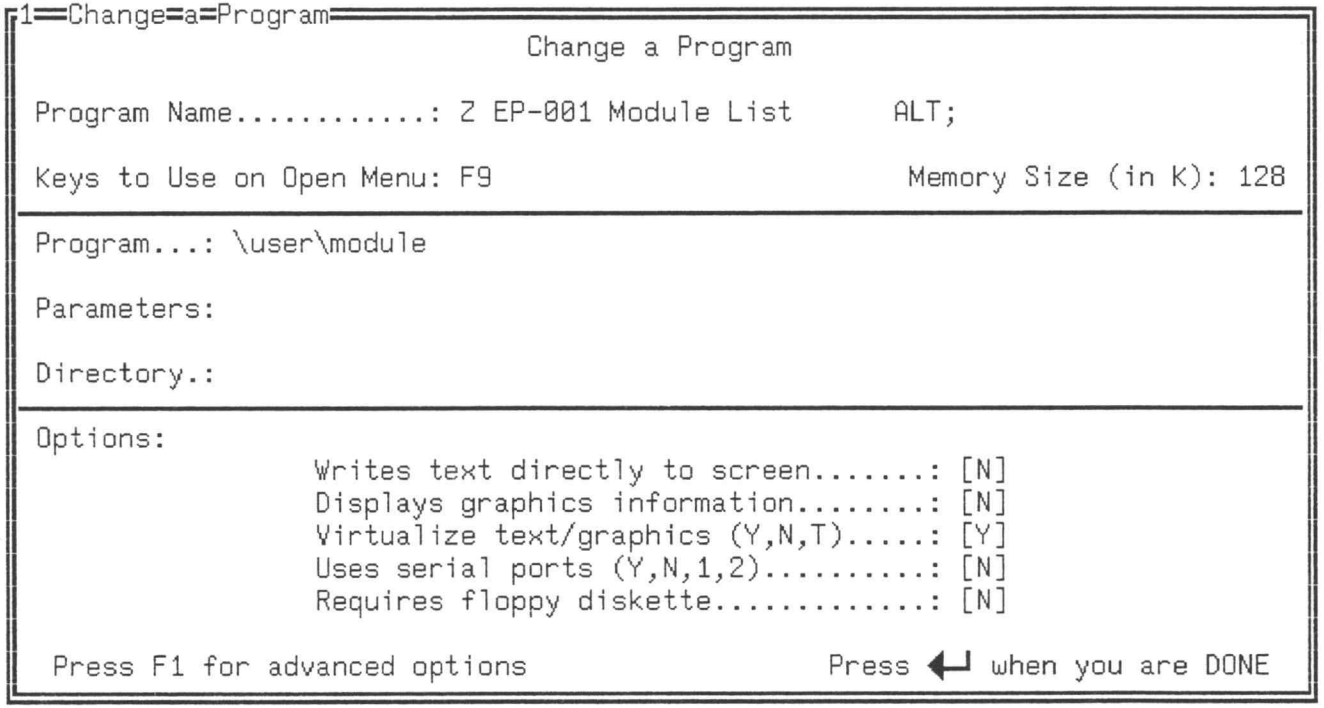

1=Change=a=Program
Change a Program Advanced Options
System Memory (in K).....: 0
Maximum Program Memory Size (in K)..: 600
Script Buffer Size.....: 1000
Maximum Expanded Memory Size (in K): 256
Text Pages: 4 Graphics Pages: 0 Initial Mode:
Interrupts: 00 to FF
Window Position:
Maximum Height: 25
Starting Height: 6
Starting Row...: 19
Maximum Width.: 80
Starting Width.: 80
Starting Column: 1
Shared Program
Pathname..:
Data.....:
Close on exit (Y,N,blank).....: [ ]
Uses its own colors.....: [Y]
Allow Close Window command.....: [Y]
Runs in background (Y,N,blank)...: [ ]
Uses math coprocessor.....: [Y]
Keyboard conflict (0-4).....: [0]
Share CPU when foreground.....: [Y]
Share EGA when foreground/zoomed.: [Y]
Can be swapped out (Y,N,blank).: [ ]
Protection level (0-3).....: [0]
Press F1 for standard options
Press ↵ when you are DONE

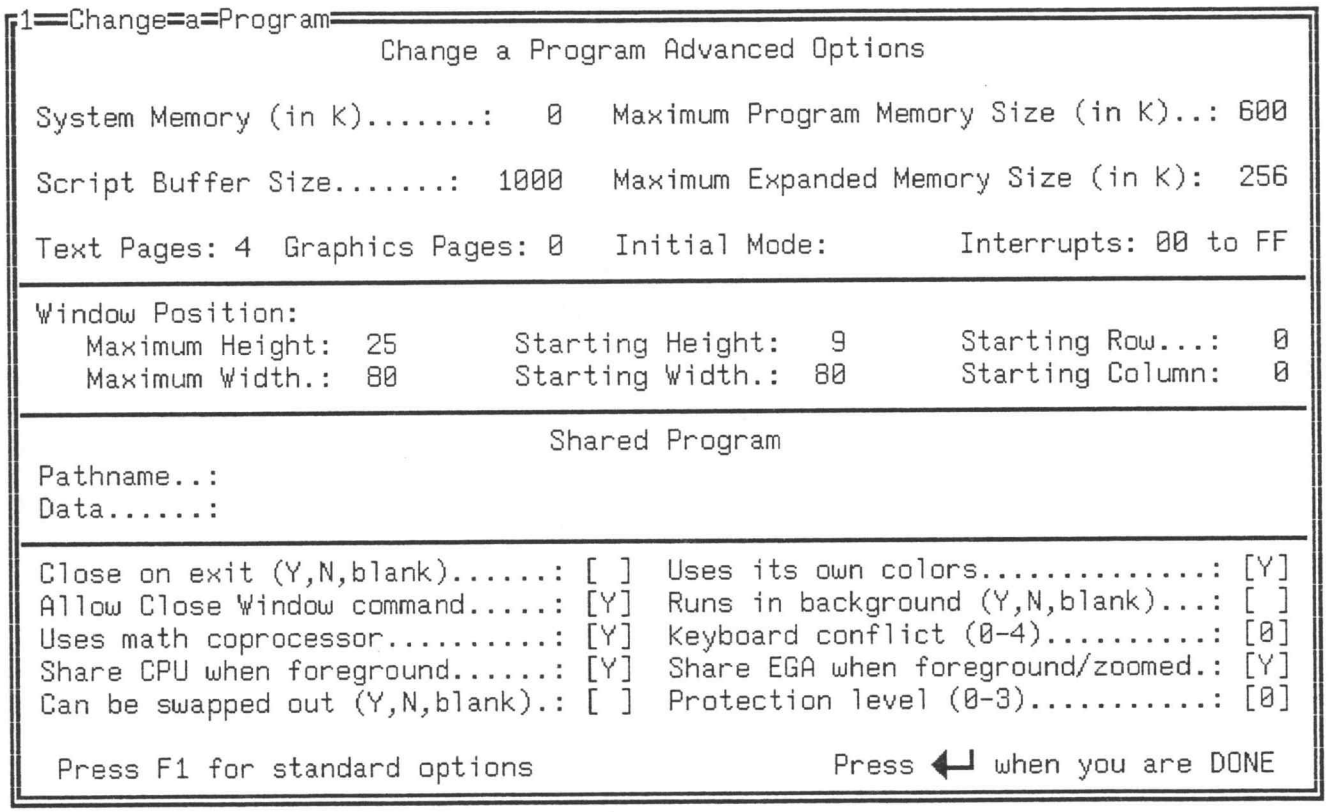

1=Change=a=Program
Change a Program
Program Name.....: XSIM: RT/EM-CLASS Demos
Keys to Use on Open Menu: SD
Memory Size (in K): 128
Program...: \user\selsim
Parameters: demo
Directory.:
Options:
Writes text directly to screen.....: [N]
Displays graphics information.....: [N]
Virtualize text/graphics (Y,N,T).....: [Y]
Uses serial ports (Y,N,1,2).....: [N]
Requires floppy diskette.....: [N]
Press F1 for advanced options
Press ↵ when you are DONE


1=Change=a=Program
Change a Program Advanced Options
System Memory (in K).....: 0
Maximum Program Memory Size (in K)..: 600
Script Buffer Size.....: 1000
Maximum Expanded Memory Size (in K): 256
Text Pages: 4 Graphics Pages: 0
Initial Mode:
Interrupts: 00 to FF
Window Position:
Maximum Height: 25
Starting Height: 25
Starting Row...: 1
Maximum Width.: 80
Starting Width.: 80
Starting Column: 1
Shared Program
Pathname..:
Data.....:
Close on exit (Y,N,blank).....: [ ]
Uses its own colors.....: [Y]
Allow Close Window command.....: [Y]
Runs in background (Y,N,blank)...: [ ]
Uses math coprocessor.....: [Y]
Keyboard conflict (0-4).....: [0]
Share CPU when foreground.....: [Y]
Share EGA when foreground/zoomed.: [Y]
Can be swapped out (Y,N,blank).: [ ]
Protection level (0-3).....: [0]
Press F1 for standard options
Press ↵ when you are DONE


1=Change=a=Program
Change a Program
Program Name.....: XT Conn to Plant Computer
Keys to Use on Open Menu: C2
Memory Size (in K): 128
Program...: xtalk
Parameters: call expert
Directory.: \xtalk4
Options:
Writes text directly to screen.....: [Y]
Displays graphics information.....: [Y]
Virtualize text/graphics (Y,N,T).....: [Y]
Uses serial ports (Y,N,1,2).....: [Y]
Requires floppy diskette.....: [N]
Press F1 for advanced options
Press ↵ when you are DONE


1=Change=a=Program
Change a Program Advanced Options
System Memory (in K).....: 0
Maximum Program Memory Size (in K)..: 600
Script Buffer Size.....: 1000
Maximum Expanded Memory Size (in K): 256
Text Pages: 4 Graphics Pages: 2 Initial Mode: Interrupts: 00 to FF
Window Position:
Maximum Height: 25
Starting Height: 25
Starting Row...: 0
Maximum Width.: 80
Starting Width.: 80
Starting Column: 0
Shared Program
Pathname..:
Data.....:
Close on exit (Y,N,blank).....: [ ]
Uses its own colors.....: [Y]
Allow Close Window command.....: [Y]
Runs in background (Y,N,blank)...: [ ]
Uses math coprocessor.....: [Y]
Keyboard conflict (0-4).....: [0]
Share CPU when foreground.....: [Y]
Share EGA when foreground/zoomed.: [Y]
Can be swapped out (Y,N,blank).: [N]
Protection level (0-3).....: [0]
Press F1 for standard options
Press ↵ when you are DONE


1=Change=a=Program
Change a Program
Program Name.....: Z EP-001 Module List ALT;
Keys to Use on Open Menu: F9
Memory Size (in K): 128
Program...: \user\module
Parameters:
Directory.:
Options:
Writes text directly to screen.....: [N]
Displays graphics information.....: [N]
Virtualize text/graphics (Y,N,T).....: [Y]
Uses serial ports (Y,N,1,2).....: [N]
Requires floppy diskette.....: [N]
Press F1 for advanced options
Press ↵ when you are DONE


1=Change=a=Program
Change a Program Advanced Options
System Memory (in K).....: 0
Maximum Program Memory Size (in K)..: 600
Script Buffer Size.....: 1000
Maximum Expanded Memory Size (in K): 256
Text Pages: 4 Graphics Pages: 0 Initial Mode: Interrupts: 00 to FF
Window Position:
Maximum Height: 25
Starting Height: 9
Starting Row...: 0
Maximum Width.: 80
Starting Width.: 80
Starting Column: 0
Shared Program
Pathname..:
Data.....:
Close on exit (Y,N,blank).....: [ ]
Uses its own colors.....: [Y]
Allow Close Window command.....: [Y]
Runs in background (Y,N,blank)...: [ ]
Uses math coprocessor.....: [Y]
Keyboard conflict (0-4).....: [0]
Share CPU when foreground.....: [Y]
Share EGA when foreground/zoomed.: [Y]
Can be swapped out (Y,N,blank).: [ ]
Protection level (0-3).....: [0]
Press F1 for standard options
Press ↵ when you are DONE

F. Inter-Computer Communications

Cross Talk is a good full service communication package that meets the needs of this project. The integration of Cross Talk with the EM-CLASS software requires that the communication process be automatic, i.e. with no user intervention whatsoever. This capability is achieved through the use of script files.

The prototype system will consist of an IBM AT and a Compaq 386. The AT will act as the plant process control computer simulator and the Compaq will hold the expert system software. The communications take place through the serial ports on both machines. A null modem cable is required. The AT serial port is a 25 pin D connector addressed through COM2 while that on the Compaq 386 is a 9 pin D connector addressed through COM1.

Aside from having the compatible communication parameters, the Cross Talk system resident on the Compaq 386 machine is set to "answer mode" which means that neither the operator nor a script file issues commands which voluntarily query information from the AT machine. The AT machine issues all commands related to the transport of the file. Since the 386 machine is in the answer mode, it is ready at any time to receive the data.

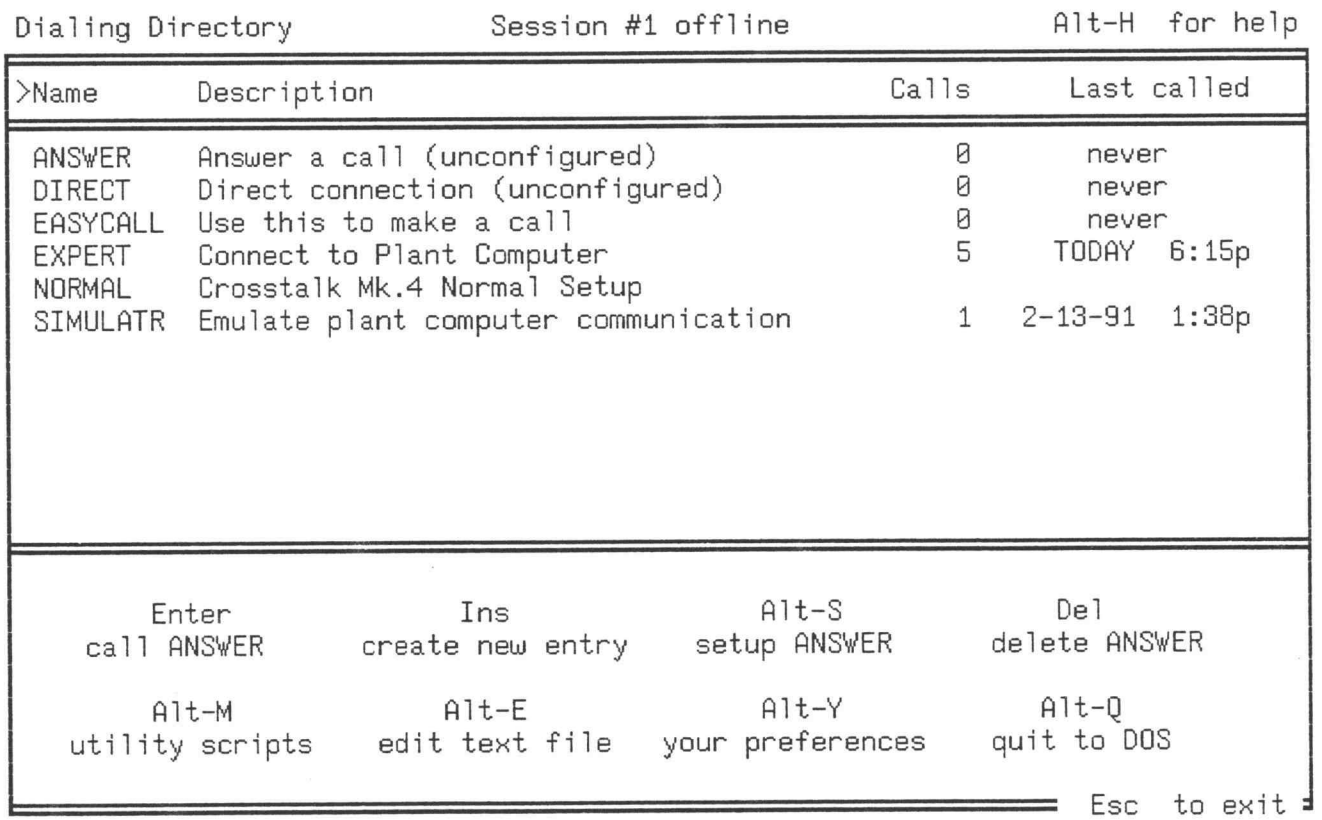
Ultimately, the computer on which EM-CLASS resides is to be connected to the plant process control computer. In the interim, a PC-AT will be used to simulate the plant process control computer. A need exists therefore to get the data from one computer to another. This will be achieved through a communications port, in this case an RS-232 port. For the reasons cited above, the communications package for the simulator is Cross Talk.

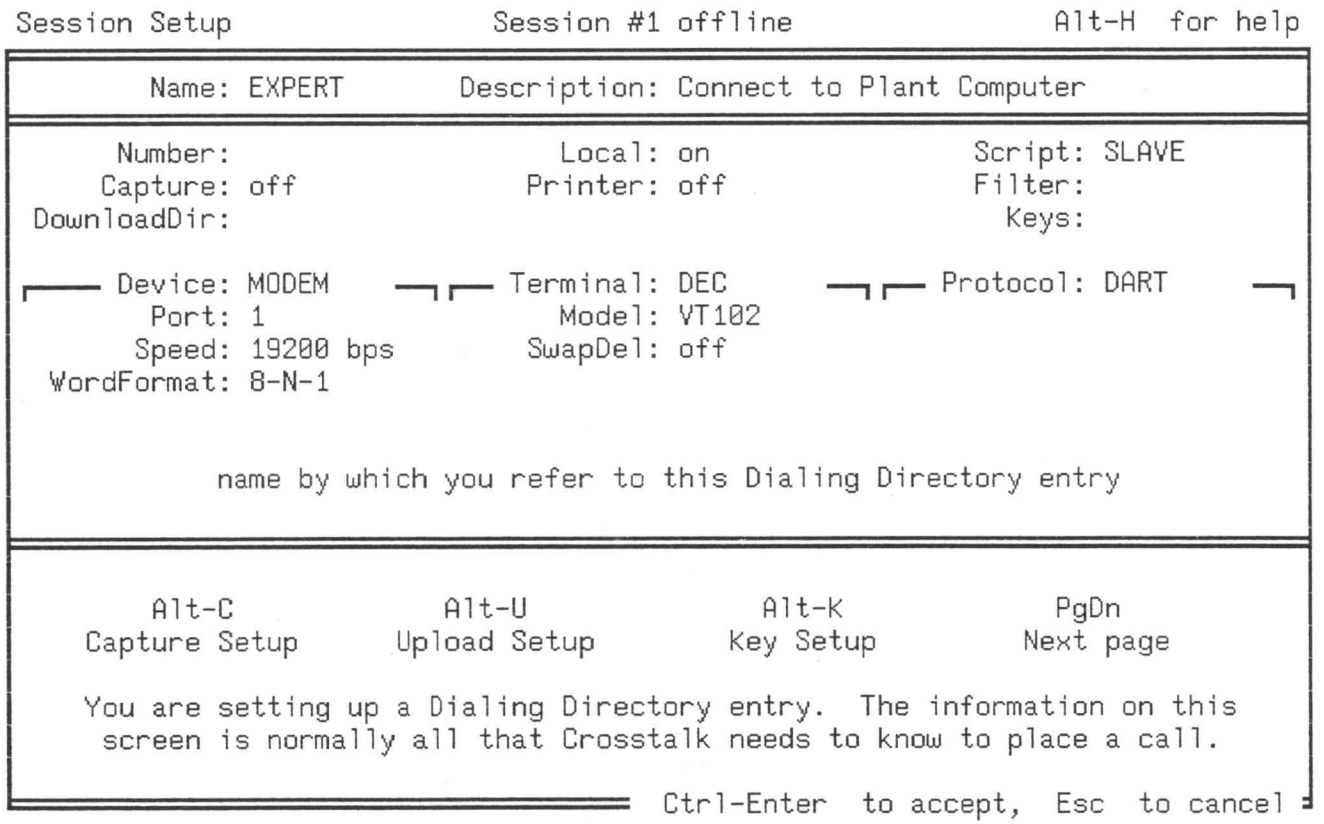
The Cross Talk application on the AT is set up in "calling mode" which means that all communication commands originate from the Cross Talk residing on this machine. This means that the transport of the data file may occur at arbitrary times as dictated by the master machine (presently an AT simulating the plant process control computer). The file transfer is by protocol to provide error checking and accurate file transfers. The current transfer rate is 9600 bps. It may be possible to turn up the speed

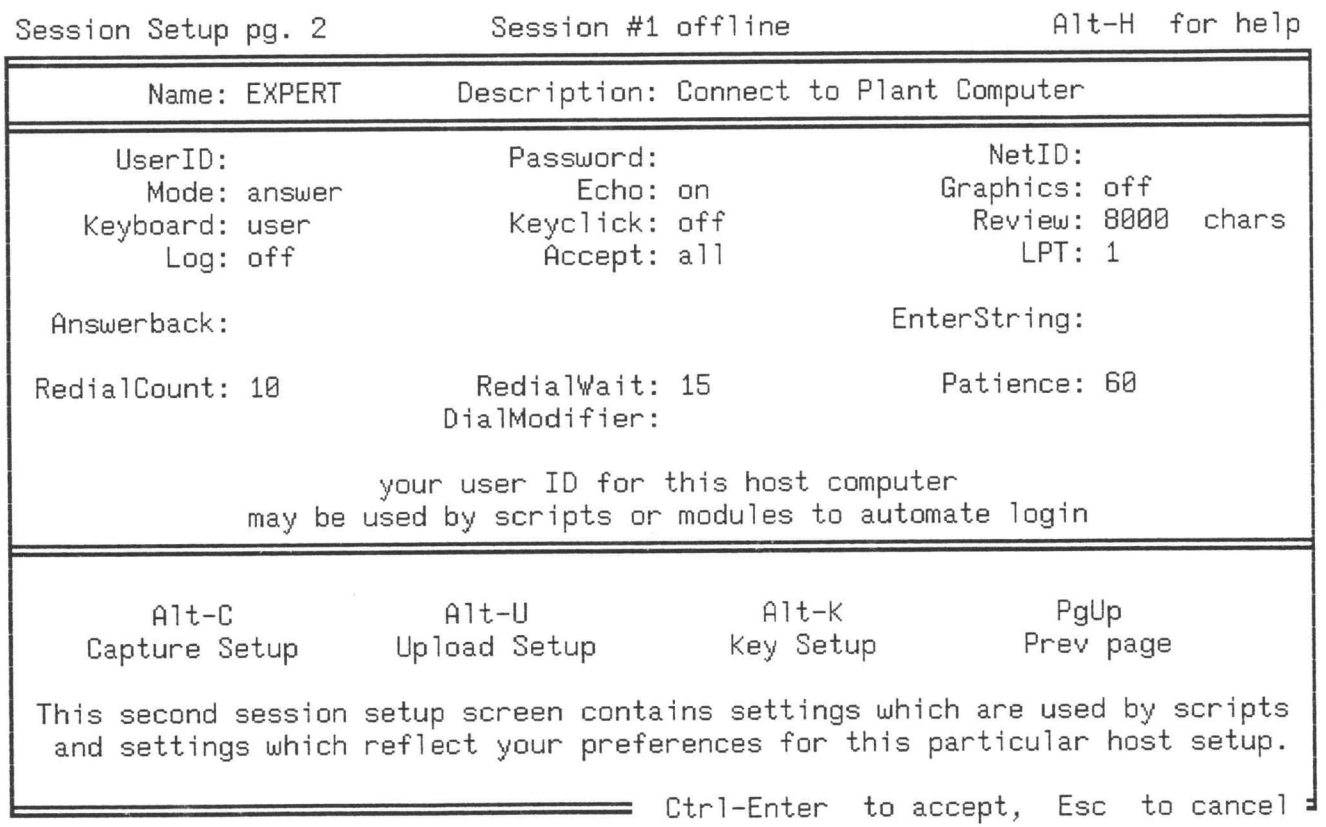
to 19,200 bps if required.

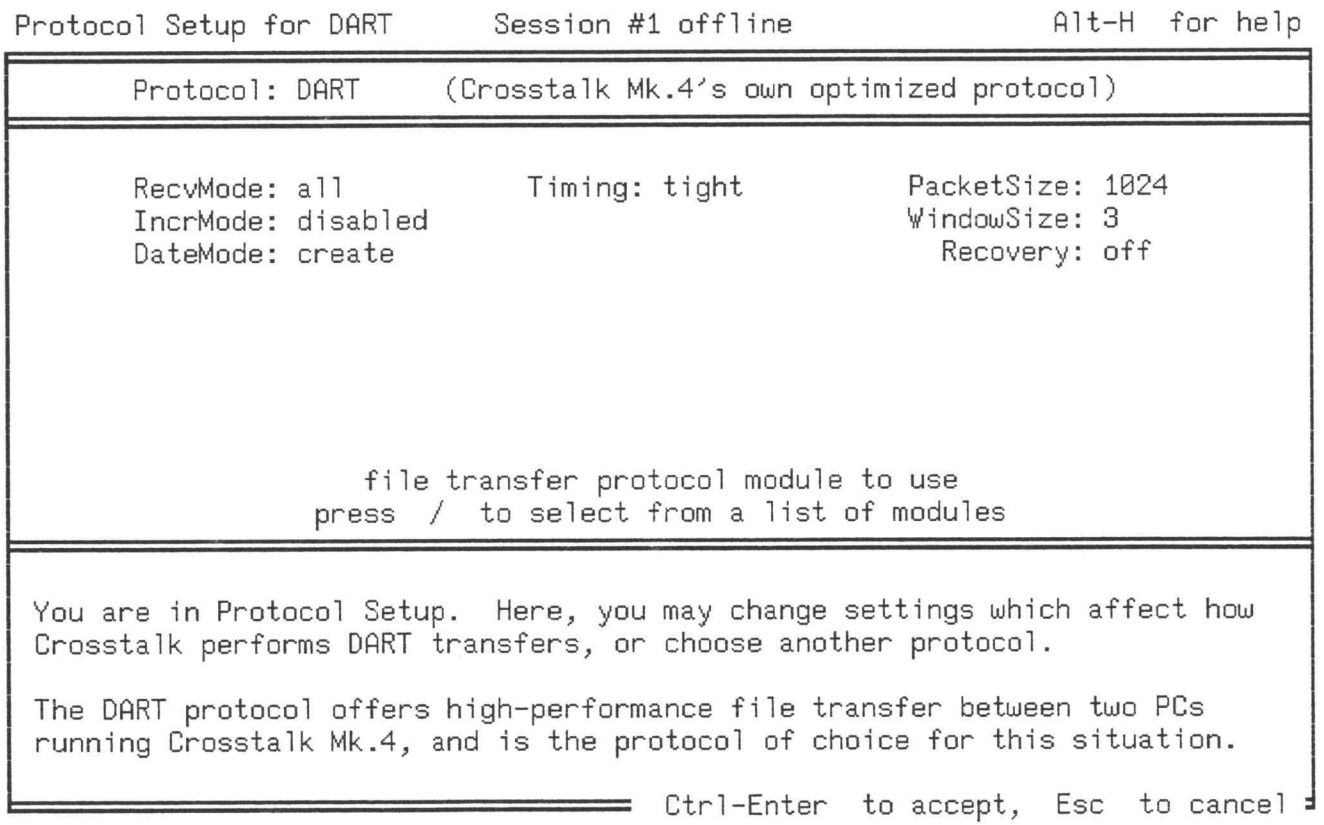
Cross Talk Configuration

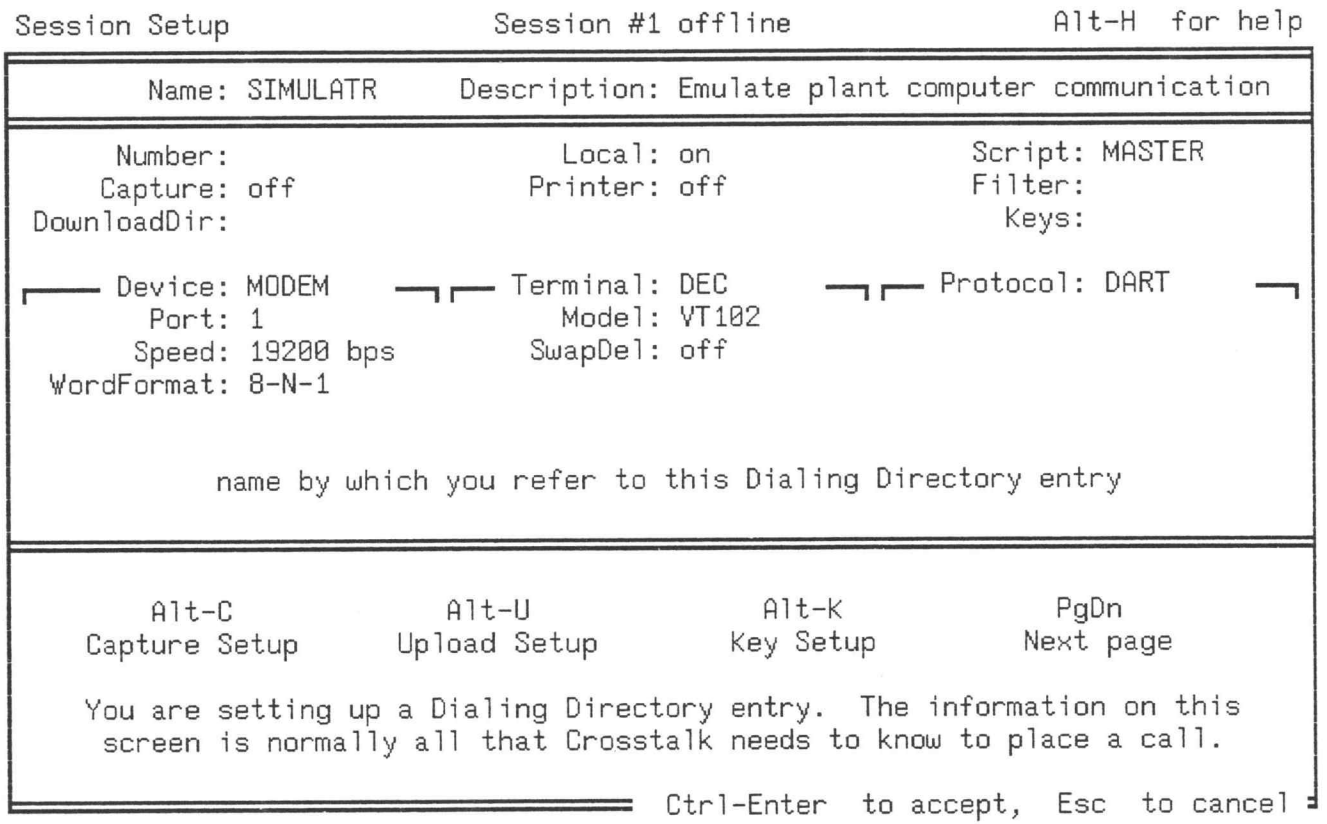
The configuration of Cross Talk on the two computers is provided on the following pages.

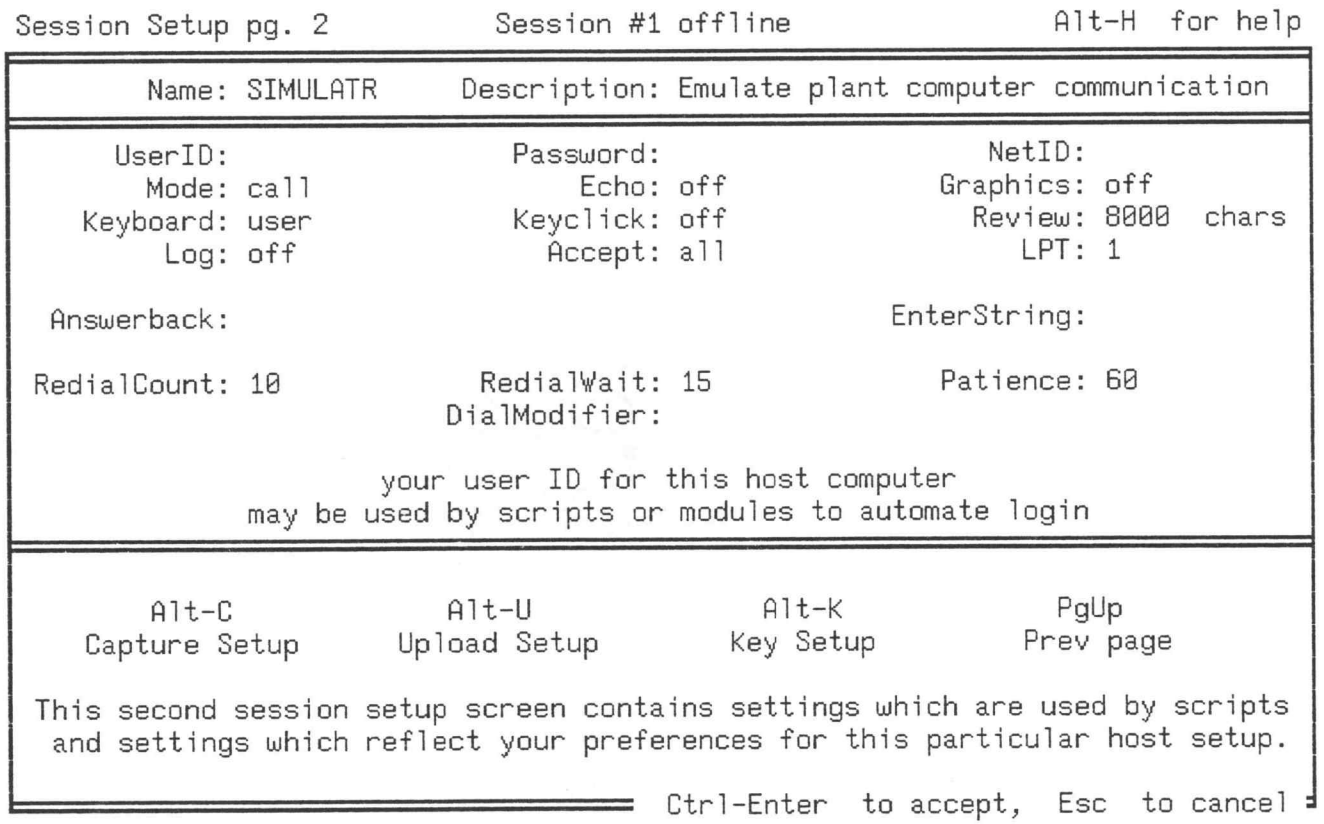

Dialing Directory
Session #1 offline
Alt-H for help
>Name
Description
Calls
Last called
ANSWER
Answer a call (unconfigured)
0
never
DIRECT
Direct connection (unconfigured)
0
never
EASYCALL
Use this to make a call
0
never
EXPERT
Connect to Plant Computer
5
TODAY 6:15p
NORMAL
Crosstalk Mk.4 Normal Setup
SIMULATR
Emulate plant computer communication
1
2-13-91 1:38p
Enter
call ANSWER
Ins
create new entry
Alt-S
setup ANSWER
Del
delete ANSWER
Alt-M
utility scripts
Alt-E
edit text file
Alt-Y
your preferences
Alt-Q
quit to DOS
Esc to exit

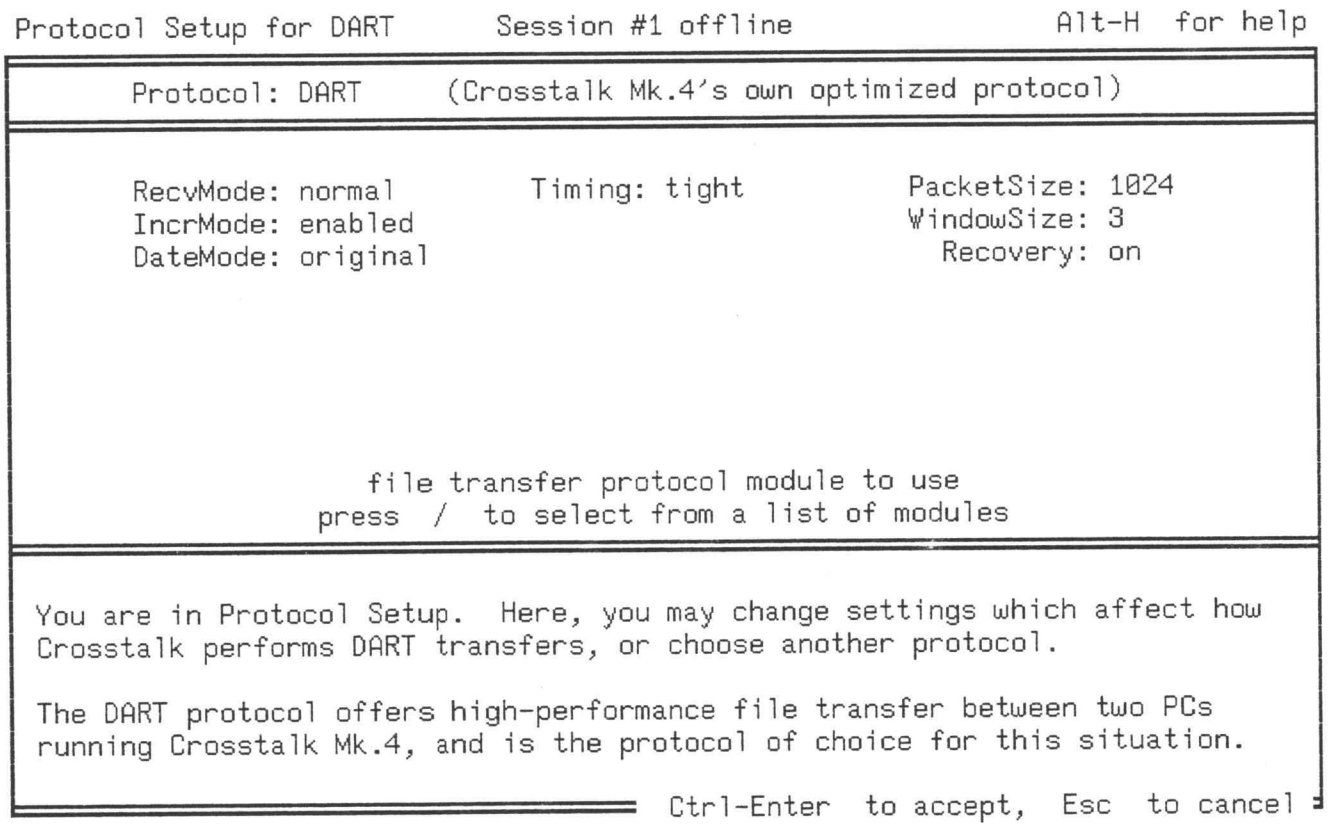

Session Setup
Session #1 offline
Alt-H for help
Name: EXPERT
Description: Connect to Plant Computer
Number:
Capture: off
DownloadDir:
Local: on
Printer: off
Script: SLAVE
Filter:
Keys:
Device: MODEM
Port: 1
Speed: 19200 bps
WordFormat: 8-N-1
Terminal: DEC
Model: VT102
SwapDel: off
Protocol: DART
name by which you refer to this Dialing Directory entry
Alt-C
Capture Setup
Alt-U
Upload Setup
Alt-K
Key Setup
PgDn
Next page
You are setting up a Dialing Directory entry. The information on this screen is normally all that Crosstalk needs to know to place a call.
Ctrl-Enter to accept, Esc to cancel


Session Setup pg. 2
Session #1 offline
Alt-H for help
Name: EXPERT
Description: Connect to Plant Computer
UserID:
Password:
NetID:
Mode: answer
Echo: on
Graphics: off
Keyboard: user
Keyclick: off
Review: 8000 chars
Log: off
Accept: all
LPT: 1
Answerback:
EnterString:
RedialCount: 10
RedialWait: 15
Patience: 60
DialModifier:
your user ID for this host computer
may be used by scripts or modules to automate login
Alt-C
Capture Setup
Alt-U
Upload Setup
Alt-K
Key Setup
PgUp
Prev page
This second session setup screen contains settings which are used by scripts
and settings which reflect your preferences for this particular host setup.
Ctrl-Enter to accept, Esc to cancel


Protocol Setup for DART
Session #1 offline
Alt-H for help
Protocol: DART (Crosstalk Mk.4's own optimized protocol)
RecvMode: all
IncrMode: disabled
DateMode: create
Timing: tight
PacketSize: 1024
WindowSize: 3
Recovery: off
file transfer protocol module to use
press / to select from a list of modules
You are in Protocol Setup. Here, you may change settings which affect how Crosstalk performs DART transfers, or choose another protocol.
The DART protocol offers high-performance file transfer between two PCs running Crosstalk Mk.4, and is the protocol of choice for this situation.
Ctrl-Enter to accept, Esc to cancel


Session Setup
Session #1 offline
Alt-H for help
Name: SIMULATR
Description: Emulate plant computer communication
Number:
Capture: off
DownloadDir:
Local: on
Printer: off
Script: MASTER
Filter:
Keys:
Device: MODEM
Port: 1
Speed: 19200 bps
WordFormat: 8-N-1
Terminal: DEC
Model: VT102
SwapDel: off
Protocol: DART
name by which you refer to this Dialing Directory entry
Alt-C
Capture Setup
Alt-U
Upload Setup
Alt-K
Key Setup
PgDn
Next page
You are setting up a Dialing Directory entry. The information on this screen is normally all that Crosstalk needs to know to place a call.
Ctrl-Enter to accept, Esc to cancel


Session Setup pg. 2
Session #1 offline
Alt-H for help
Name: SIMULATR
Description: Emulate plant computer communication
UserID:
Password:
NetID:
Mode: call
Echo: off
Graphics: off
Keyboard: user
Keyclick: off
Review: 8000 chars
Log: off
Accept: all
LPT: 1
Answerback:
EnterString:
RedialCount: 10
RedialWait: 15
Patience: 60
DialModifier:
your user ID for this host computer
may be used by scripts or modules to automate login
Alt-C
Capture Setup
Alt-U
Upload Setup
Alt-K
Key Setup
PgUp
Prev page
This second session setup screen contains settings which are used by scripts
and settings which reflect your preferences for this particular host setup.
Ctrl-Enter to accept, Esc to cancel


Protocol Setup for DART
Session #1 offline
Alt-H for help
Protocol: DART (Crosstalk Mk.4's own optimized protocol)
RecvMode: normal
IncrMode: enabled
DateMode: original
Timing: tight
PacketSize: 1024
WindowSize: 3
Recovery: on
file transfer protocol module to use
press / to select from a list of modules
You are in Protocol Setup. Here, you may change settings which affect how Crosstalk performs DART transfers, or choose another protocol.
The DART protocol offers high-performance file transfer between two PCs running Crosstalk Mk.4, and is the protocol of choice for this situation.
Ctrl-Enter to accept, Esc to cancel

G. Data Processing Process Control and Software

To initiate the data processing process, use the batch file

```
SELDPR.BAT
```

This batch file executes the following command

```
c:\greene\dpr\dprlib\dpr_%1\stage %1 %2
```

A copy of the file DELAY.FOR

```
CDELAY
C-----------------------------------------------------------------------
C  PROGRAM:       delay.for
C-----------------------------------------------------------------------
C  DESCRIPTION:  This program permits a programmable delay to be used
C                for control in a real time process monitoring
C                application.
C-----------------------------------------------------------------------
C  DEVELOPED BY:  Ken Greene
C                 Department of Nuclear Engineering
C                 Oregon State University
C                 Corvallis, Oregon
C
C                 July 1989
C-----------------------------------------------------------------------
C
      PROGRAM delay

      CHARACTER*24 filnam
      CHARACTER*12 status
      INTEGER isec

C-----------------------------------------------------------------------
C     *** Open files

      filnam = "dtime.prm"              ! This file holds the user specified
      iounit = 2                        !     delay time in seconds
      status = "UNKNOWN"

      CALL filopn(iounit,filnam,status)

      OPEN (UNIT=19,
     B      ACCESS = "SEQUENTIAL",
     C      STATUS = "SCRATCH"
     E      )

C     *** Input data

      CALL gettim(isec)
      istart = isec

C     *** Read data from sensor.dat file
```

```
      READ (2,*) idelay
C      WRITE (*,999)
C 999  FORMAT (79('='))
C      WRITE (*,*) " "
C      WRITE (*,*) " "

C     *** Loop until elapsed time is reached

      nsec = 0

 100  CONTINUE

      CALL gettim(isec)
      idelt = (istart + idelay) - isec
      IF (idelt .NE. nsec) THEN
         nsec = idelt
         WRITE (*,900) nsec
         END IF
 900  FORMAT (1H+,"Next Update Begins in: ",I4," sec")
      IF (idelt .GT. 0) GOTO 100

C      WRITE (*,*) " "

C     *** Close files

      CLOSE (2)
      CLOSE (19)

      END
CGETTIM
      SUBROUTINE gettim(stime)

      INTEGER hrnow,minnow,secnow,stime
      CHARACTER*8 now

      CALL TIME(now)                                  ! Retrieve current time
      REWIND (19)                                     ! Rewind scratch file
      WRITE (19,910) now                              ! Write char time to file
 910  FORMAT (A8)
      REWIND (19)                                     ! Rewind scratch file
      READ (19,900) hrnow,minnow,secnow               ! Read time as integer
 900  FORMAT (I2,1X,I2,1X,I2)

C     *** Compute elapsed time

      stime = 3600*hrnow+60*minnow+secnow

      RETURN
      END
CFILOPN
      SUBROUTINE filopn(iounit,name,status)

      CHARACTER*24 name
      CHARACTER*12 status
      INTEGER errmrk

      icount = 2000

  50  CONTINUE

      OPEN (UNIT   = iounit,
     A      FILE   = name,
     B      ACCESS = "SEQUENTIAL",
```

```
     C       STATUS = status,
     D       IOSTAT = errmrk
     E       )

      IF (errmrk .eq. 0) GO TO 100
      icount = icount - 1
      WRITE (06,900) errmrk
 900  FORMAT (1H+,'File Request Response:  ',I10)

      IF (icount .GT. 0) GO TO 50
      WRITE (*,*) ' '
      WRITE (*,*) 'File Opening Error!!!'
      STOP

 100  CONTINUE

      RETURN
      END
```

The contents of the file DPR.FOR:

```
CDPR
C     *** Process Control Computer Simulator and
C     *** Data Acquisition Program

      PROGRAM dpr

      CHARACTER*24 filnam
      CHARACTER*12 status,trnd
      CHARACTER*6 symbol(150),label
      CHARACTER*45 desc(150),descr
      DIMENSION varray(150),array(10),work(150),high5(5)

      nmax = 100

C-----------------------------------------------------------------------

      nhist = 10           ! Number of points retained in history

C-----------------------------------------------------------------------

  10  CONTINUE

C-----------------------------------------------------------------------
C     *** initialize sensor variables

      anil = -999.

      DO 40 i = 1,nmax
         varray(i) = anil
  40  CONTINUE


C-----------------------------------------------------------------------
C     Read sensor data and assign to mnemonic variables

      filnam = "c:\xtalk4\reading.dat"   ! This file holds current values of
      iounit = 1                         !     sensor data that correspond with
      status = "OLD"                     !     the current time in the
                                         !     simulation
      CALL filopn(iounit,filnam,status,80,imrk)
```

```
      filnam = "labels.txt"              ! This file holds current values of
      iounit = 2                         !     sensor data that correspond with
      status = "OLD"                     !     the current time in the
                                         !     simulation
      CALL filopn(iounit,filnam,status,80,imrk)

      icnt = 0
 50   CONTINUE

      READ (1,900,END=100) label,valu
900   FORMAT (A6,1X,E10.4)
      READ (2,901) descr
901   FORMAT (A45)
      icnt = icnt + 1

      varray(icnt) = valu
      symbol(icnt) = label
      desc(icnt) = descr
      IF (label .EQ. 'T1000 ') index  = icnt - 1
      IF (label .EQ. 'R1000 ') index1 = icnt - 1
      GO TO 50

 100  CONTINUE

      CLOSE (1)
      CLOSE (2)

      IF (varray(1) .LT. 0.) GO TO 10  ! If no values, go to start

      isec = INT(varray(1))

C     *** Write time to file for use by simuser

      filnam = "timeis.now"
      iounit = 22
      status = "UNKNOWN"

      CALL filopn(iounit,filnam,status,80,imrk)

      WRITE (22,877) isec
 877  FORMAT (1H ,I8)
      CLOSE (22)

C     *** Display time and column headings for changing parameters

C      WRITE (*,*) 'Elapsed Time: ',isec, ' seconds'
C      WRITE (*,*) ' '
C      WRITE (*,*) 'System Parameters Which Are Changing'
C      WRITE (*,*) ' '
C      WRITE (*,*) '    Value        Description                Trend'
C      WRITE (*,*) '    -----        -----------                -----'

C-------------------------------------------------------------------------
C     *** Update history data

      filnam = "hist.dat"
      status = "UNKNOWN"

      CALL filopn(3,filnam,status,1200,imrk)

      OPEN (UNIT   = 4,
     A      ACCESS = "SEQUENTIAL",
     B      STATUS = "SCRATCH",
```

```
     C      RECL   = 1200)

      iflag = 0

      WRITE (*,999)
 999  FORMAT (/////)

      DO 150 k = 1,icnt

      READ (3,910,END=200) label,(array(i),i=1,nhist) ! Init. if unexpected
                                                      ! EOF is reached
 910  FORMAT (A6,1X,100(E10.4,1X))

      iflag = 1

C     *** Displace history data 1 point to left, dropping oldest
C     *** data.  Add newest data to nhist-th position.

      WRITE (4,910) symbol(k),(array(i),i=2,nhist),varray(k)

C     *** Display parameters which have changed value.  This
C     *** is based on 1% change between two readings.

      valu1 = array(nhist)
      valu2 = varray(k)
      IF (valu2 .EQ. 0) THEN
         chk = 100.*(valu1-valu2)
      ELSE
         chk = 100.*(valu1-valu2)/valu2
      END IF
      IF (valu1 .LT. -100. .OR. valu2 .LT. -100.) GO TO 191
      IF (ABS(chk) .LT. 1.) GO TO 191
      IF (chk .GT. 0) THEN
         trnd = 'DECREASING'
      ELSE
         trnd = 'INCREASING'
      END IF

      IF (k .EQ. 1) GO TO 191

      WRITE (*,907) valu2,desc(k),trnd
 907  FORMAT (1H ,E12.4,3X,A45,3X,A12)
 191  CONTINUE

 150  CONTINUE

 200  CONTINUE

      IF (iflag .NE. 0) GO TO 219

C     *** Initialize array at start of simulation

      DO 218 i = 1,icnt
         WRITE (4,910) symbol(i),anil,anil,anil,anil,anil,
     A                           anil,anil,anil,anil,anil

 218  CONTINUE
 219  CONTINUE

      REWIND 3
      REWIND 4

 220  CONTINUE
```

```
      READ (4,910,END=240) label,(array(k),k=1,10)
      WRITE (3,910) label,(array(k),k=1,10)

      GO TO 220

 240  CONTINUE

      CLOSE (3)
      CLOSE (4)

C=====================================================================
C     *** Compute/Set EM-CLASS parameters
C---------------------------------------------------------------------

C     *** sort core thermocouple temperatures

      icount = 0
      DO 327 i = index+1,icnt
         icount = icount + 1
         work (icount) = varray(i)
 327  CONTINUE

      DO 367 k = 1,5
         valu1 = work(1)
         mplace = 1
         DO 357 j = 2,icnt-index
            IF (work(j) .GT. valu1) THEN
               valu1 = work(j)
               mplace = j
            END IF
 357     CONTINUE
         work (mplace) = 0.
         high5(k) = valu1
 367  CONTINUE

      filnam = "event1.dat"
      status = "UNKNOWN"

      CALL filopn(2,filnam,status,80,imrk)

      DO 257 k = 1,index1
         WRITE (2,988) varray(k)
 988  FORMAT (1H ,'(',F12.1,')')
 257  CONTINUE

      WRITE (2,988) high5(5)
      CLOSE (2)


      filnam = "event2.dat"
      status = "UNKNOWN"

      CALL filopn(2,filnam,status,80,imrk)

      DO 258 k = index1+1,index
         WRITE (2,988) varray(k)
 258  CONTINUE

      WRITE (2,988) high5(5)
      CLOSE (2)
C---------------------------------------------------------------------
```

```
C       WRITE (*,999)
C 999   FORMAT (79('='))


      END
CFILOPN
      SUBROUTINE filopn(iounit,name,status,irec,imrk)

      CHARACTER*24 name
      CHARACTER*12 status

      OPEN (19,FILE="fec.err",ACCESS="APPEND",STATUS="UNKNOWN")

      icount = 2000

  50  CONTINUE

      OPEN (UNIT   = iounit,
     A      FILE   = name,
     B      ACCESS = "SEQUENTIAL",
     C      STATUS = status,
     D      RECL   = irec,
     E      IOSTAT = imrk
     F      )

      IF (imrk .NE. 0) WRITE (06,900) imrk
      IF (imrk .NE. 0) WRITE (19,*) name,imrk
      IF (imrk .EQ. 0) GO TO 100
      icount = icount - 1
 900  FORMAT (1H ,'File Request Response:  ',I10)

      IF (icount .GT. 0) GO TO 50
      WRITE (*,*) ' '
      WRITE (*,*) 'File Opening Error!!!'
      STOP

 100  CONTINUE
      CLOSE (19)

      RETURN
      END
```

The file DTIME.PRM

```
20
```

The file EVENT1.DAT

```
(         0.0)
(         1.0)
(         1.0)
(       100.0)
(       100.0)
(       100.0)
(       100.0)
(         0.0)
(         0.0)
(         0.0)
(         0.0)
(         1.0)
```

```
(       100.0)
(       100.0)
(        10.0)
(        10.0)
(        10.0)
(        10.0)
(      2000.0)
(         1.2)
(         1.0)
(       556.0)
```

The file EVENT2.DAT

```
(         1.0)
(         1.0)
(       100.0)
(        10.0)
(         1.0)
(         1.0)
(         1.0)
(        50.0)
(        10.0)
(         1.0)
(       100.0)
(         1.0)
(        50.0)
(       100.0)
(    350000.0)
(        50.0)
(        50.0)
(        50.0)
(        50.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         1.0)
(         0.1)
(         0.1)
(       500.0)
(       500.0)
(       500.0)
(       500.0)
(       556.0)
```

File GREADING.DAT

```
time    0.0000E+00
ED1067  0.1000E+01
ED1068  0.1000E+01
F1059   0.1000E+03
F1060   0.1000E+03
F1061   0.1000E+03
F1062   0.1000E+03
MD1073  0.0000E+00
MD1074  0.0000E+00
MD1075  0.0000E+00
MD1076  0.0000E+00
L1048   0.1000E+01
L1052   0.1000E+03
L1053   0.1000E+03
M1000   0.1000E+02
M1002   0.1000E+02
M1004   0.1000E+02
M1006   0.1000E+02
P1001   0.2000E+04
P1046   0.1200E+01
P1047   0.1000E+01
R1000   0.1000E+01
R1001   0.1000E+01
R1002   0.1000E+03
R1003   0.1000E+02
R1004   0.1000E+01
R1005   0.1000E+01
R1006   0.1000E+01
R1007   0.5000E+02
R1008   0.1000E+02
R1009   0.1000E+01
R1014   0.1000E+03
R1015   0.1000E+01
R1018   0.5000E+02
R1019   0.1000E+03
R1020   0.3500E+06
R1023   0.5000E+02
R1024   0.5000E+02
R1025   0.5000E+02
R1026   0.5000E+02
R1038   0.1000E+01
R1039   0.1000E+01
R1040   0.1000E+01
R1041   0.1000E+01
R1042   0.1000E+01
R1043   0.1000E+01
R1044   0.1000E+01
R1045   0.1000E+01
R1046   0.1000E+01
R1047   0.1000E+01
R1048   0.1000E+01
R1049   0.1000E+01
R1050   0.1000E+01
R1051   0.1000E+01
R1052   0.1000E+01
R1053   0.1000E+01
R1054   0.1000E+01
R1055   0.1000E+01
```

```
R1056  0.1000E+01
R1057  0.1000E+01
R1058  0.1000E+01
R1059  0.1000E+01
R1060  0.1000E+00
R1061  0.1000E+00
T1119  0.5000E+03
T1121  0.5000E+03
T1123  0.5000E+03
T1125  0.5000E+03
T1000  0.5600E+03
T1001  0.5580E+03
T1002  0.5560E+03
T1003  0.5540E+03
T1004  0.5520E+03
T1005  0.5510E+03
T1006  0.5530E+03
T1008  0.5550E+03
T1009  0.5570E+03
T1010  0.5590E+03
T1011  0.5500E+03
T1012  0.5500E+03
T1013  0.5500E+03
T1014  0.5500E+03
T1015  0.5500E+03
T1016  0.5500E+03
T1017  0.5500E+03
T1018  0.5500E+03
T1019  0.5500E+03
T1020  0.5500E+03
T1021  0.5500E+03
T1022  0.5500E+03
T1023  0.5500E+03
T1024  0.5500E+03
T1025  0.5500E+03
T1026  0.5500E+03
T1027  0.5500E+03
T1028  0.5500E+03
T1029  0.5500E+03
T1030  0.5500E+03
T1031  0.5500E+03
T1032  0.5500E+03
T1033  0.5500E+03
T1034  0.5500E+03
T1035  0.5500E+03
T1036  0.5500E+03
T1037  0.5500E+03
T1038  0.5500E+03
T1039  0.5500E+03
T1040  0.5500E+03
T1041  0.5500E+03
T1042  0.5500E+03
T1043  0.5500E+03
T1044  0.5500E+03
T1045  0.5500E+03
T1046  0.5500E+03
T1047  0.5500E+03
T1048  0.5500E+03
T1049  0.5500E+03
T1050  0.5500E+03
T1051  0.5500E+03
T1052  0.5500E+03
T1053  0.5500E+03
```

```
T1054  0.5500E+03
T1055  0.5500E+03
T1056  0.5500E+03
T1057  0.5500E+03
T1058  0.5500E+03
T1059  0.5500E+03
T1061  0.5500E+03
T1062  0.5500E+03
T1063  0.5500E+03
T1064  0.5500E+03
```

File HIST.DAT

```
time    -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
ED1067 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
ED1068 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
F1059  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
F1060  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
F1061  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
F1062  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
MD1073 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
MD1074 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
MD1075 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
MD1076 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
L1048  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
L1052  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
L1053  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
M1000  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
M1002  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
M1004  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
M1006  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
P1001  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
P1046  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
P1047  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1000  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1001  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1002  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1003  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1004  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1005  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1006  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1007  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1008  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1009  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1014  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1015  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1018  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1019  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1020  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1023  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1024  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1025  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1026  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1038  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1039  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1040  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1041  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1042  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1043  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1044  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
R1045  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
```

R1046	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1047	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1048	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1049	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1050	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1051	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1052	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1053	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1054	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1055	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1056	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1057	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1058	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1059	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1060	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
R1061	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1119	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1121	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1123	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1125	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1000	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1001	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1002	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1003	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1004	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1005	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1006	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1008	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1009	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1010	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1011	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1012	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1013	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1014	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1015	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1016	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1017	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1018	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1019	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1020	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1021	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1022	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1023	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1024	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1025	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1026	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1027	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1028	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1029	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1030	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1031	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1032	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1033	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1034	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1035	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1036	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1037	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1038	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1039	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1040	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1041	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1042	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3
T1043	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3	-.99E+3

```
T1044  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1045  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1046  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1047  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1048  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1049  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1050  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1051  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1052  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1053  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1054  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1055  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1056  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1057  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1058  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1059  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1061  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1062  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1063  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
T1064  -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3 -.99E+3
```

File LABELS.TXT

```
Time
Containment Vent Isol Tr. A
Containment Vent Isol Tr. B
Aux FW Flow to SG A
Aux FW Flow to SG B
Aux FW Flow to SG C
Aux FW Flow to SG D
SG A Blowdown Isolation
SG B Blowdown Isolation
SG C Blowdown Isolation
SG D Blowdown Isolation
Containment sump level - Wide (A)
RVLIS - Full Range Tr. A
RVLIS - Full Range Tr. B
Wind Speed El. 33 ft (A)
Wind Speed El. 33 ft (B)
Wind Speed El. 200 ft
Wind Speed El. 500 ft
RCS pressure - wide range
Containment pressure - wide range #1
Containment pressure - wide range #2
PRM-1A: Containment particulate
PRM-1B: Containment iodine
PRM-1C: Containment vent low noble gas
PRM-1D: Containment vent high noble gas
PRM-1E: Containment vent hi-hi noble gas
PRM-2A: Aux Bldg Exh Particulate
PRM-2B: Aux Bldg Exh iodine
PRM-2C: Aux bldg vent low noble gas
PRM-2D: Aux bldg vent high noble gas
PRM-3: Spent fuel pool ventilation
PRM-6B: Air ejector high noble gas
PRM-6C: Air ejector hi-hi noble gas
PRM-9: Liquid Rad-waste discharge
PRM-10: Steam generator blowdown
PRM-13: Gross failed fuel
PRM-16A:  Main Steam Line A
PRM-16B:  Main Steam Line B
```

PRM-16C: Main Steam Line C
PRM-16D: Main Steam Line D
ARM-1: Aux Bldg, El 5'
ARM-2: Aux Bldg, El 25'
ARM-3: Radiation sample room
ARM-4: Aux Bldg, El 45'
ARM-5: Fuel pool area, El 45'
ARM-6: In-core monitoring equip
ARM-7: Aux Bldg, El 61'
ARM-8: Fuel Bldg, El 61'
ARM-9: Radwaste control
ARM-10: Waste concentrates tank
ARM-11: Control room
ARM-12: Maintenance shop
ARM-13: New fuel storage
ARM-14: Radwaste drumming station
ARM-15A: Cont. El 133', Press. shed
ARM-15B: Cont. El 106', Laydown area
ARM-16: RHR Room West
ARM-17: RHR Room East
ARM-18: VCT Room, Facade
ARM-19: Letdown line, Facade
ARM-20: Manipulator crane
ARM-21: Entry to bioshield
ARM-22: Site boundary North
ARM-23: Site boundary South
RC Loop A Tavg
RC Loop B Tavg
RC Loop C Tavg
RC Loop D Tavg
In-Core Temperature A08
In-Core Temperature B03
In-Core Temperature B10
In-Core Temperature C08
In-Core Temperature C13
In-Core Temperature D03
In-Core Temperature E04
In-Core Temperature E08
In-Core Temperature E10
In-Core Temperature F12
In-Core Temperature F15
In-Core Temperature G02
In-Core Temperature G09
In-Core Temperature G11
In-Core Temperature H01
In-Core Temperature H03
In-Core Temperature H08
In-Core Temperature H13
In-Core Temperature J10
In-Core Temperature K03
In-Core Temperature K05
In-Core Temperature K15
In-Core Temperature L01
In-Core Temperature L08
In-Core Temperature L12
In-Core Temperature M10
In-Core Temperature M13
In-Core Temperature N03
In-Core Temperature N09
In-Core Temperature P05
In-Core Temperature P11
In-Core Temperature R08
In-Core Temperature A09

```
In-Core Temperature A11
In-Core Temperature B05
In-Core Temperature C03
In-Core Temperature C12
In-Core Temperature D07
In-Core Temperature D09
In-Core Temperature E02
In-Core Temperature E14
In-Core Temperature F05
In-Core Temperature F09
In-Core Temperature F11
In-Core Temperature G04
In-Core Temperature G08
In-Core Temperature H05
In-Core Temperature H09
In-Core Temperature H11
In-Core Temperature H14
In-Core Temperature J07
In-Core Temperature K11
In-Core Temperature K13
In-Core Temperature L02
In-Core Temperature L09
In-Core Temperature L14
In-Core Temperature M05
In-Core Temperature M12
In-Core Temperature N02
In-Core Temperature N13
In-Core Temperature P07
In-Core Temperature R05
In-Core Temperature R10
```

The commands in the file STAGE.BAT are

```
echo off
c:
cd \greene\dpr\dprlib\dpr_%1
xcopy delay.exe      %2\greene\dpr\*.*  /s  >NUL
copy dpr.exe         %2\greene\dpr\*.*       >NUL
copy dtime.prm       %2\greene\dpr\*.*       >NUL
copy greading.dat    %2\greene\dpr\*.*       >NUL
copy labels.txt      %2\greene\dpr\*.*       >NUL
copy xdpr.bat        %2\greene\dpr\*.*       >NUL
copy xcopy.ans       %2\greene\dpr\*.*       >NUL
%2
cd \greene\dpr
call xdpr
```

The file TIMEIS.NOW

```
0
```

The commands in the batch file XDPR.BAT are

```
ECHO OFF
CD \GREENE\DPR
XCOPY GREADING.DAT c:\XTALK4\READING.DAT /S <xcopy.ans >NUL
COPY DPR.EXE       \PCPLUS\*.*             >NUL
COPY LABELS.TXT    \PCPLUS\*.*             >NUL
```

```
COPY DELAY.EXE      \PCPLUS\*.*             >NUL
COPY DTIME.PRM      \PCPLUS\*.*             >NUL
CD \PCPLUS
ERASE HIST.DAT  >NUL
:LOOP
DPR
DELAY
GOTO :LOOP
```

H. Plant Computer Simulation Software and Control

File SELSIM.BAT

```
c:\greene\sim\simlib\sim_%1\stage %1 %2
```

File BANNER1.TXT

```
#######  ###  #     # #    # #       ##    #######  #####  #####
#         #   ##   ## #    # #      #  #      #    #     # #    #
#######   #   # # # # #    # #     #    #     #    #     # #####
      #   #   #  #  # #    # #     ######     #    #     # #  #
#######  ###  #     # ###### ###### #    #     #     #####  #   #
```

File DELAY.FOR - See appendix entry in DPR section

File DTIME.PRM - See appendix entry in DPR section

File SENSOR.DAT

```
ED1067          0.        1.    Containment Vent Isol Tr. A
             2000.        1.
$
ED1068          0.        1.    Containment Vent Isol Tr. B
             2000.        1.
$
F1059           0.      100.    Aux FW Flow to SG A
             2000.      100.
$
F1060           0.      100.    Aux FW Flow to SG B
             2000.      100.
$
F1061           0.      100.    Aux FW Flow to SG C
             2000.      100.
$
F1062           0.      100.    Aux FW Flow to SG D
             2000.      100.
$
MD1073          0.        0.    SG A Blowdown Isolation
             2000.        0.
$
MD1074          0.        0.    SG B Blowdown Isolation
             2000.        0.
$
MD1075          0.        0.    SG C Blowdown Isolation
             2000.        0.
$
MD1076          0.        0.    SG D Blowdown Isolation
             2000.        0.
$
```

```
L1048            0.        1.    Containment sump level - Wide (A)
              2000.        1.
$
L1052            0.      100.    RVLIS - Full Range Tr. A
              2000.      100.
$
L1053            0.      100.    RVLIS - Full Range Tr. B
              2000.      100.
$
M1000            0.       10.    Wind Speed - El. 33 ft (A)
              2000.       10.
$
M1002            0.       10.    Wind Speed - El. 33 ft (B)
              2000.       10.
$
M1004            0.       10.    Wind Speed - El. 200 ft
              2000.       10.
$
M1006            0.       10.    Wind Speed - El. 500 ft
              2000.       10.
$
P1001            0.     2000.    RCS pressure - wide range
              2000.     2000.
$
P1046            0.        1.2   Containment pressure - wide range #1
               500.        1.2
               504.        1.4
               520.        1.8
               540.        2.3
               560.        2.4
               580.        2.6
               600.        3.2
               640.        3.2
               680.        3.7
               720.        4.3
               760.        5.2
               780.        5.3
               820.        5.7
               900.        6.0
               912.        8.0
               920.       17.3
               940.       19.0
               960.       19.3
              1020.       19.6
              1080.       19.9
              1140.       20.3
              1200.       21.6
              1260.       14.6
              1340.        7.6
              1380.        3.5
              1440.          0.
$
P1047            0.        1.    Containment pressure - wide range #2
              2000.        1.
$
R1000            0.        1.    PRM-1A: Containment particulate
              2000.        1.
$
R1001            0.        1.    PRM-1B: Containment iodine
              2000.        1.
$
R1002            0.      100.    PRM-1C: Containment vent low noble gas
              2000.      100.
```

```
$
R1003            0.        10.    PRM-1D: Containment vent high noble gas
              2000.        10.
$
R1004            0.         1.    PRM-1E: Containment vent hi-hi noble gas
              2000.         1.
$
R1005            0.         1.    PRM-2A: Aux Bldg Exh Particulate
              2000.         1.
$
R1006            0.         1.    PRM-2B: Aux Bldg Exh iodine
              2000.         1.
$
R1007            0.        50.    PRM-2C: Aux bldg vent low noble gas
                60.        50.
               120.        50.
               180.        50.
               188.     50000.
               240.     52000.
               300.     52000.
               360.     50000.
               420.     35000.
               460.        50.
              2000.        50.
$
R1008            0.        10.    PRM-2D: Aux bldg vent high noble gas
              2000.        10.
$
R1009            0.         1.    PRM-3: Spent fuel pool ventilation
              2000.         1.
$
R1014            0.       100.    PRM-6B: Air ejector high noble gas
              2000.       100.
$
R1015            0.         1.    PRM-6C: Air ejector hi-hi noble gas
              2000.         1.
$
R1018            0.        50.    PRM-9: Liquid Rad-waste discharge
              2000.        50.
$
R1019            0.       100.    PRM-10: Steam generator blowdown
              2000.       100.
$
R1020            0.    350000.    PRM-13: Gross failed fuel
                60.    380000.
               480.    380000.
               520.    400000.
               540.    500000.
              2000.    500000.
$
R1023            0.        50.    PRM-16A:  Main Steam Line A
              2000.        50.
$
R1024            0.        50.    PRM-16B:  Main Steam Line B
              2000.        50.
$
R1025            0.        50.    PRM-16C:  Main Steam Line C
              2000.        50.
$
R1026            0.        50.    PRM-16D:  Main Steam Line D
              2000.        50.
$
R1038            0.         1.    ARM-1: Aux Bldg, El 5'
```

```
              2000.        1.
$
R1039            0.        1.    ARM-2: Aux Bldg, El 25'
              2000.        1.
$
R1040            0.        1.    ARM-3: Radiation sample room
              2000.        1.
$
R1041            0.        1.    ARM-4: Aux Bldg, El 45'
              2000.        1.
$
R1042            0.        1.    ARM-5: Fuel pool area, El 45'
              2000.        1.
$
R1043            0.        1.    ARM-6: In-core monitoring equip
              2000.        1.
$
R1044            0.        1.    ARM-7: Aux Bldg, El 61'
              2000.        1.
$
R1045            0.        1.    ARM-8: Fuel Bldg, El 61'
              2000.        1.
$
R1046            0.        1.    ARM-9: Radwaste control
              2000.        1.
$
R1047            0.        1.    ARM-10: Waste concentrates tank
              2000.        1.
$
R1048            0.        1.    ARM-11: Control room
              2000.        1.
$
R1049            0.        1.    ARM-12: Maintenance shop
              2000.        1.
$
R1050            0.        1.    ARM-13: New fuel storage
              2000.        1.
$
R1051            0.        1.    ARM-14: Radwaste drumming station
              2000.        1.
$
R1052            0.        1.    ARM-15A: Cont. El 133', Press. shed
              2000.        1.
$
R1053            0.        1.    ARM-15B: Cont. El 106', Laydown area
              2000.        1.
$
R1054            0.        1.    ARM-16: RHR Room West
              2000.        1.
$
R1055            0.        1.    ARM-17: RHR Room East
              2000.        1.
$
R1056            0.        1.    ARM-18: VCT Room, Facade
              2000.        1.
$
R1057            0.        1.    ARM-19: Letdown line, Facade
              2000.        1.
$
R1058            0.        1.    ARM-20: Manipulator crane
              2000.        1.
$
R1059            0.        1.    ARM-21: Entry to bioshield
```

```
             2000.        1.
$
R1060           0.        0.1    ARM-22: Site boundary North
             2000.        0.1
$
R1061           0.        0.1    ARM-23: Site boundary South
             2000.        0.1
$
T1119           0.      500.     RC Loop A Tavg
             2000.      500.
$
T1121           0.      500.     RC Loop B Tavg
             2000.      500.
$
T1123           0.      500.     RC Loop C Tavg
             2000.      500.
$
T1125           0.      500.     RC Loop D Tavg
             2000.      500.
$
T1000           0.      560.     In-Core Temperature A08
             2000.      560.
$
T1001           0.      558.     In-Core Temperature B03
             2000.      558.
$
T1002           0.      556.     In-Core Temperature B10
             2000.      556.
$
T1003           0.      554.     In-Core Temperature C08
             2000.      554.
$
T1004           0.      552.     In-Core Temperature C13
             2000.      552.
$
T1005           0.      551.     In-Core Temperature D03
             2000.      551.
$
T1006           0.      553.     In-Core Temperature E04
             2000.      553.
$
T1008           0.      555.     In-Core Temperature E08
             2000.      555.
$
T1009           0.      557.     In-Core Temperature E10
             2000.      557.
$
T1010           0.      559.     In-Core Temperature F12
             2000.      559.
$
T1011           0.      550.     In-Core Temperature F15
             2000.      550.
$
T1012           0.      550.     In-Core Temperature G02
             2000.      550.
$
T1013           0.      550.     In-Core Temperature G09
             2000.      550.
$
T1014           0.      550.     In-Core Temperature G11
             2000.      550.
$
T1015           0.      550.     In-Core Temperature H01
```

```
              2000.      550.
$
T1016            0.      550.    In-Core Temperature H03
              2000.      550.
$
T1017            0.      550.    In-Core Temperature H08
              2000.      550.
$
T1018            0.      550.    In-Core Temperature H13
              2000.      550.
$
T1019            0.      550.    In-Core Temperature J10
              2000.      550.
$
T1020            0.      550.    In-Core Temperature K03
              2000.      550.
$
T1021            0.      550.    In-Core Temperature K05
              2000.      550.
$
T1022            0.      550.    In-Core Temperature K15
              2000.      550.
$
T1023            0.      550.    In-Core Temperature L01
              2000.      550.
$
T1024            0.      550.    In-Core Temperature L08
              2000.      550.
$
T1025            0.      550.    In-Core Temperature L12
              2000.      550.
$
T1026            0.      550.    In-Core Temperature M10
              2000.      550.
$
T1027            0.      550.    In-Core Temperature M13
              2000.      550.
$
T1028            0.      550.    In-Core Temperature N03
              2000.      550.
$
T1029            0.      550.    In-Core Temperature N09
              2000.      550.
$
T1030            0.      550.    In-Core Temperature P05
              2000.      550.
$
T1031            0.      550.    In-Core Temperature P11
              2000.      550.
$
T1032            0.      550.    In-Core Temperature R08
              2000.      550.
$
T1033            0.      550.    In-Core Temperature A09
              2000.      550.
$
T1034            0.      550.    In-Core Temperature A11
              2000.      550.
$
T1035            0.      550.    In-Core Temperature B05
              2000.      550.
$
T1036            0.      550.    In-Core Temperature C03
```

```
              2000.      550.
$
T1037            0.      550.    In-Core Temperature C12
              2000.      550.
$
T1038            0.      550.    In-Core Temperature D07
              2000.      550.
$
T1039            0.      550.    In-Core Temperature D09
              2000.      550.
$
T1040            0.      550.    In-Core Temperature E02
              2000.      550.
$
T1041            0.      550.    In-Core Temperature E14
              2000.      550.
$
T1042            0.      550.    In-Core Temperature F05
              2000.      550.
$
T1043            0.      550.    In-Core Temperature F09
              2000.      550.
$
T1044            0.      550.    In-Core Temperature F11
              2000.      550.
$
T1045            0.      550.    In-Core Temperature G04
              2000.      550.
$
T1046            0.      550.    In-Core Temperature G08
              2000.      550.
$
T1047            0.      550.    In-Core Temperature H05
              2000.      550.
$
T1048            0.      550.    In-Core Temperature H09
              2000.      550.
$
T1049            0.      550.    In-Core Temperature H11
              2000.      550.
$
T1050            0.      550.    In-Core Temperature H14
              2000.      550.
$
T1051            0.      550.    In-Core Temperature J07
              2000.      550.
$
T1052            0.      550.    In-Core Temperature K11
              2000.      550.
$
T1053            0.      550.    In-Core Temperature K13
              2000.      550.
$
T1054            0.      550.    In-Core Temperature L02
              2000.      550.
$
T1055            0.      550.    In-Core Temperature L09
              2000.      550.
$
T1056            0.      550.    In-Core Temperature L14
              2000.      550.
$
T1057            0.      550.    In-Core Temperature M05
```

```
              2000.      550.
$
T1058            0.      550.    In-Core Temperature M12
              2000.      550.
$
T1059            0.      550.    In-Core Temperature N02
              2000.      550.
$
T1061            0.      550.    In-Core Temperature N13
              2000.      550.
$
T1062            0.      550.    In-Core Temperature P07
              2000.      550.
$
T1063            0.      550.    In-Core Temperature R05
              2000.      550.
$
T1064            0.      550.    In-Core Temperature R10
              2000.      550.
$
```

File SIMULATR.FOR

```
CSIMULATR
C-----------------------------------------------------------------------
C  PROGRAM:      simulatr.for
C-----------------------------------------------------------------------
C  DESCRIPTION:  This program simulates the process control
C                computer at TROJAN.  Its purpose is to produce
C                simulated sensor readings for the emergency
C                classification expert system EM-CLASS
C-----------------------------------------------------------------------
C  DEVELOPED BY:  Ken Greene
C                 Department of Nuclear Engineering
C                 Oregon State University
C                 Corvallis, Oregon
C
C                 July 1989
C-----------------------------------------------------------------------
C
      PROGRAM simulatr

      CHARACTER*12 filnam,status
      CHARACTER*6 label
      CHARACTER*1 mark
      CHARACTER*80 title
      CHARACTER*45 ident
      INTEGER isec
      DIMENSION xtab(50),ytab(50)

C-----------------------------------------------------------------------
C     *** Display banner

      filnam = "banner1.txt"
      iounit = 1
      status = "OLD"

      CALL filopn(iounit,filnam,status)

   8  CONTINUE
```

```
      READ (1,899,END=9) title
  899 FORMAT (A80)

      WRITE (*,899) title
      GO TO 8

    9 CONTINUE

      CLOSE (1)

C-----------------------------------------------------------------------
C     *** Open files
                                        ! This file holds the data describing
      filnam = "sensor.dat"             !     time dependent behavior of
      iounit = 1                        !     sensor readings being
      status = "OLD"                    !     simulated

      CALL filopn(iounit,filnam,status)

      filnam = "reading.dat"            ! This file holds current values of
      iounit = 2                        !     sensor data that correspond with
      status = "UNKNOWN"                !     the current time in the
                                        !     simulation
      CALL filopn(iounit,filnam,status)

      filnam = "start.tim"              ! This file holds the time
      iounit = 3                        !     corresponding to the start of
      status = "UNKNOWN"                !     the simulation

      CALL filopn(iounit,filnam,status)

      OPEN (UNIT   = 19,
     B      ACCESS = "SEQUENTIAL",
     C      STATUS = "SCRATCH"
     E      )

C     *** Input data

      CALL gettim(isec)
      tyme = FLOAT(isec)
      WRITE (2,959) 'time',tyme
  959 FORMAT (A4,3X,E10.4)
      WRITE (*,*) 'Elapsed Time: ',isec,' seconds'
      simtim = FLOAT(isec)

  100 CONTINUE

C     *** Read data from sensor.dat file

      READ (1,900,END=800) mark,label,p1,p2,ident
  900 FORMAT (A1,T1,A6,4X,2F10.0,A45)

      xtab(1) = p1
      ytab(1) = p2

      itab = 1

  120 CONTINUE
         itab = itab + 1
         READ (1,900,END=130) mark,lname,xtab(itab),ytab(itab)
         IF (mark .NE. '$') GO TO 120

  130 CONTINUE
```

```
C     *** Compute what sensor reading should be at the current time

      state = valu(simtim,xtab,ytab,itab-1)

C     *** Place sensor reading in file reading.dat

      WRITE (2,960) label,state
 960  FORMAT (A6,1X,E10.4)
      GO TO 100

 800  CONTINUE

C     *** Close files

      CLOSE (1)
      CLOSE (2)
      CLOSE (3)
      CLOSE (19)

      END
CVALU
      FUNCTION valu(x,t,f,n)

      DIMENSION t(50),f(50)

C     *** Locate two points to interpolate between

      icnt = 0
      DO 10 i = 1,n-1
         IF (x .LT. t(i)) GO TO 10
         icnt = icnt + 1
  10  CONTINUE

C     *** linear interpolation/extrapolation

      j = icnt
      valu = f(j) + (x - t(j)) / (t(j+1) - t(j))*(f(j+1) - f(j))

      RETURN
      END

CGETTIM
      SUBROUTINE gettim(stime)

      INTEGER hrnow,minnow,secnow,hour,minute,second,stime
      CHARACTER*8 now

      CALL TIME(now)                                  ! Retrieve current time
      READ (3,900,ERR=100) hour,minute,second         ! Read start time; if error
 900  FORMAT (I2,1X,I2,1X,I2)                         !     then initialize time
      REWIND (19)                                     ! Rewind scratch file
      WRITE (19,910) now                              ! Write char time to file
 910  FORMAT (A8)
      REWIND (19)                                     ! Rewind scratch file
      READ (19,900) hrnow,minnow,secnow               ! Read time as integer

C     *** Compute elapsed time

      IF (secnow .LT. second) THEN
         secnow = secnow + 60                         ! Subtraction borrow
         minnow = minnow - 1
         END IF
```

```
      IF (minnow .LT. minute) THEN
         minnow = minnow + 60                          ! Subtraction borrow
         hrnow = hrnow - 1
         END IF

      IF (hrnow .LT. hour) THEN
         hrnow = hrnow + 24                            ! Adjust for new day
         END IF

      stime = 3600*(hrnow-hour)+60*(minnow-minute)+(secnow-second)

      GO TO 110

C     *** Set start time of simulation

 100  CONTINUE                                          ! Initialize simulation

      stime = 0
      WRITE (3,910) now

C     *** Return start time

 110  CONTINUE

      RETURN
      END
CFILOPN
      SUBROUTINE filopn(iounit,name,status)

      CHARACTER*12 name
      CHARACTER*12 status
      INTEGER errmrk

      icnt = 0

  50  CONTINUE

      icnt = icnt + 1
      OPEN (UNIT   = iounit,
     A      FILE   = name,
     B      ACCESS = "SEQUENTIAL",
     C      STATUS = status,
     D      IOSTAT = errmrk
     E      )

      IF (errmrk .eq. 0) GO TO 100

      WRITE (06,900) icnt,name,errmrk
 900  FORMAT (I4,'  File opening error...',A12,5X,'iostat = ',I6)
      IF (icnt .LT. 100) GO TO 50
      STOP

 100  CONTINUE

      RETURN
      END
```

File STAGE.BAT

```
echo off
```

```
c:
cd \greene\sim\simlib\sim_%1
xcopy delay.exe      %2\greene\sim\*.*  /s   >NUL
copy simulatr.exe    %2\greene\sim\*.*       >NUL
copy dtime.prm       %2\greene\sim\*.*       >NUL
copy banner1.txt     %2\greene\sim\*.*       >NUL
copy sensor.dat      %2\greene\sim\*.*       >NUL
copy xsim.bat        %2\greene\sim\*.*       >NUL
%2
cd \greene\sim
xsim
```

File XSIM.BAT

```
ECHO OFF
call \user\envrnmnt
cd \greene\sim
ERASE START.TIM
:LOOP
SIMULATR
COPY READING.DAT \XTALK4
DELAY
GOTO :LOOP
```

I. Hardware/Software Requirements

The process monitoring RT/EM-CLASS application prototype requires the following:

Hardware:

- Compaq 386 Deskpro (or compatible) with 2 MB of RAM and Hard Disk
- IBM PC-AT (or compatible) with Hard Disk
- Null Modem Cable w/Compatible Serial Port Connectors

Commercial Software:

- Personal Consultant™ Plus (Texas Instruments, Inc.)
- Online (Texas Instruments, Inc.)
- Desqview (Quarterdeck, Inc.)
- Cross Talk (Microstuf, Inc.)